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Exploring the relationship between Kinetic User Interfaces and exercise motivation in youths – an exploratory study.

Master thesis
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Abstract

The aim of this thesis was to explore the relationship between Kinetic User Interfaces (KUI) and exercise motivation in youths. This thesis divided this exploration into three sections, and began by examining how the KUI could differ from other more traditional and familiar interfaces. This was done through heuristic evaluations that revealed the KUI's ability and necessity to provide good continuous feedback to be its most outstanding advantage. Secondly, this thesis continued by investigating and eliciting the most prominent conditions for the facilitation of exercise motivation in youth. By both collecting original data through journals and discussing them with respect to relevant literature, this thesis concluded that the most significant condition was the inherent psychological need for competence. Thirdly and finally in the study of the relationship between exercise motivation and the KUI, this thesis proceeded by exploring the challenges of attempting to facilitate the feeling of competence through exercise feedback from an application with a KUI. This exploration was conducted using personas, group brainstorming, concept elicitation methods, high-fidelity prototyping, and user testing. The results indicated that this relationship was more problematic than anticipated as several challenges were explored, namely the problem with feedback overload, weaknesses in the user testing methods, and several unforeseen usability issues. Conclusively this thesis has provided insights into how KUIs are compared with other interfaces, how exercise motivation is best facilitated in youth, and it has also illuminated some other challenges that might influence the exploration of the relationship between exercise motivation and the Kinetic User Interface.

Keywords: Kinetic User Interface, Interaction Design, Exercise motivation

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1 Introduction

As interaction designers are interested in the interaction between the application and its users, any device that can impact that interaction is naturally of great interest. The buttons on the keyboard allows the user to send one-dimensional binary signals to the application. The mouse lets the user communicate with a single point in two-dimensions. Multi-touch screens not only increased the number of interaction points, but they also brought the user's hands physically closer to the application's interface by eliminating intermediary devices. Microphones and mobile computers allowed the application to hear and know where the user was, and finally today's Kinetic User Interface devices allows the application for the first time, in any meaningful sense, to actually see him/her. This thesis is interested in studying the relationships such interaction can facilitate, and more specifically, the relationship to exercise motivation.

1.1 Personal motivation

We both realized quite early on that we wanted to work on something related to the Microsoft Kinect. At that time, the technology was just released in the consumer market and we were excited to explore the possibilities it could bring forth. Earlier during our studies, we had the pleasure of working with other platforms such as small mobile touch-screen devices, medium-sized touch-screen tablet devices, and large multi-touch surfaces. We found the exploration of these fairly novel and non-traditional interfaces engaging, and therefore, the Kinect immediately fascinated us. We believed it would provide a new and rich channel for communication between the computer and the user, and we were interested in the potential relationships that would emerge.

This thesis is an excuse for exploring our intrinsic curiosity of this relationship.

1.2 Scientific motivation

As interaction design is primarily concerned with the relationship between the technology and its users, the commercialization of a new and novel interface is naturally of great interest. This thesis hopes to investigate, analyze, and understand how this new Kinetic User Interface is different or similar to more familiar interfaces. Further, to explore the potential advantages and weaknesses of employing this interface in the facilitation of exercise motivation, the researchers wishes to gain a better understanding of the conditions that may facilitate such motivation. However, considering the limited scope of an exploratory study, this thesis recognizes the limited applicability of its results, hence its ambitions are not to conclude as to how this interface may improve exercise motivation, but instead to lay potential foundations for future research into the combination of Kinetic User Interfaces and exercise motivation.

Obesity, as a growing medical concern, has received substantial amount of focus and commitment from the research community in recent years. While many conditions have been found to cause and sustain this growing development, one major aspect is the increasing sedentation of people’s lifestyles, which is arguable associated with the increasing mergence of technology in everyday life. Considering that the Kinetic User Interface is fairly new to the commercial markets and that it requires significant body movements of the user, this thesis wishes to explore how this novel interface can be related to the facilitation of exercise for the de-sedentation of today’s lifestyles.

1.3 Research field and research questions

This thesis' scientific ambition is to contribute a potential foundation to the research community in the study of Kinetic User Interfaces (KUI) and exercise motivation. An appropriate method for investigating this is to perform an exploratory study and note the outstanding forthcoming findings to then analyze and discuss them. As part of this exploration this thesis will begin by examining the KUI in comparison with more familiar interfaces to deduce how it is both different and similar. Further, it will strive to inquire how exercise motivation is induced in youth. Finally, this thesis will attempt to combine the elicited essential and advantageous aspect of KUI with the most prominent conditions that facilitate exercise motivation in the designing of a KUI prototype as a peripheral application to an existing KUI application. Thereafter, the prototype will be exposed to user testing where meaningful findings and observations will be collected and subsequently discussed.

In eliciting one aspect that is both essential and advantageous for a KUI application, this thesis defines its first research question:

1. Which aspects are essential for a KUI application to provide a good user experience and usability compared with applications with other interfaces?

To investigate this question this thesis will collect and modify some existing applications to function with both their original interface and the new KUI. These applications will then be subject to heuristic evaluation with special focus on the interface and the subsequent user experience.

2. Which conditions are most prominent in facilitating motivation for exercise?

To deduce the most prominent conditions for exercise motivation in youth, this thesis will rely on both existing literature as well as original data, which it will collect using journals. The data will then be analyzed and processed into personas that will be continuously used in the remaining study.

Finally, to collect findings about studying the relationship between a KUI and exercise motivation, this thesis will perform an exploratory experiment aimed at developing a prototype to facilitate exercise motivation. The prototype was chosen to be a peripheral application that would complement other existing KUI applications, partially because that was more feasible to develop than a stand-alone application, partially so as to reduce the likelihood of bias due to personal preferences in applications, but mostly to draw advantage of the user engagement that some existing KUI applications already offered.

Additionally, since this thesis performs an exploratory study of the relationship between peripheral KUI applications and exercise motivation in youths, this thesis recognizes that any results from such an exploratory study would be considered of limited applicability to the scientific community, due to the small population size involved. Therefore, this thesis found it more prudent to focus on the challenges that would arise when exploring this relationship. The results from such a focus would be a stronger contribution to the science of interaction design. This investigation is hence formulated into the following research question:

3. Which challenges are relevant when exploring the relationship between exercise motivation and feedback from a peripheral KUI application?

This thesis will investigate this research question by first inviting potential users to develop ideas and subsequently concepts for a prototype. Thereafter, this thesis will continue by prioritizing and selecting a concept to further develop into a prototype. This prototype will finally be exposed to user testing. By executing such an exploration of the relationship between exercise motivation and feedback from a peripheral KUI application, this thesis will first-hand encounter, collect, and discuss the challenges that arose.

However, to formally contextualize this research in the field of interaction design this thesis will begin by reviewing relevant literature. This literature will primarily provide a basis for the discussion of the findings.

2 Theory

This chapter will present the main theoretical subjects related to this thesis. These subjects are interaction design and motivation theory. This chapter will begin by introducing the main concept of interaction design as well as user experience, usability, design principles and design approaches. A brief overview of different user interfaces will also be given. Further, this chapter will continue by examining some theories concerned with motivation such as the self-determination theory, self-efficacy, and flow theory.

2.1 Interaction design

Interaction Design is described as "*Designing interactive products to support the way people communicate and interact in their everyday and working lives.*" (Preece et al., 2007). Additionally, Norman states that to achieve great design, one has to humanize technology, i.e. to make it disappear (Bergman & Norman, 2000). One has to design the technology to make it a part of everyday life, so that it feels like the most natural thing in life. In an interview in 2002, Smith said that Interaction Design is about "*shaping our everyday life through digital artifacts – for work, for play and for entertainment*" (Moggridge, 2007). Interaction design is about shaping our lives through interactive technology in the same way that industrial designers have done by designing the everyday objects that occur in our lives, like our furniture, kitchen tools, vehicles, etc. (Moggridge, 2007).

Like other design disciplines, interaction design is not only concerned with form, but also on the product's behavior as well (Cooper et al., 2007). Interaction design is concerned with the design of behavior, but also how the content and the form of the product relates to that behavior. There are many different areas that contribute to the field of Interaction Design. It is not solely associated with design, nor is it solely associated with computer science. It also encompasses disciplines such as cognitive science, information science, and engineering as well. However the disciplines that are most influential to interaction design are psychology, computer science, ergonomics, and sociological factors (Preece et al., 2007).

2.2 User experience

At the time of writing there is no agreed unique definition of the term "user experience" (UX) in the field of Interaction Design. There are however several contributions and proposals. According to Garret, a user experience is the experience a product creates for the people who use it (Garret, 2002). It is not concerned with how a product works on the inside, but instead the experience it facilitates when a user interacts with it. Another more specific and perhaps more elaborate definition of the term is that of Hassenzahl and Tractinsky:

"User experience is about technology that fulfills more than just instrumental needs in a way that acknowledges its use as a subjective, situated, complex and dynamic encounter. User experience is a consequence of a user's internal state –, characteristics of designed system – and the context – within the interaction occurs." (Hassenzahl & Tractinsky, 2006).

Considering this description of user experience, it is understandable that any user experience goal is difficult to define. However, it is reasonable to conclude that an application facilitates a positive user experience if its user's mental state is positively influenced by it.

Even though the terms "user experience" and "usability" have a tendency to be used interchangeably (Hassenzahl, 2008), there is a clear distinction between them (Preece et al., 2007). As usability goals are more objective and concerned with how useful a product is from its own perspective, user experience's primary focus lies on the feel and emotion a product provides from a subjective point of view. This is in accordance with Hassenzahl, who states that user experience is closely linked to human emotions. He introduced two different ways human emotions are connected to user experience (Hassenzahl & Tractinsky, 2006). The first perspective credits the emotions to be a result of a product when used, while the other perspective credits and emphasizes the user's mood prior to product use to be the cause of the user experience (Singh & Dalal, 1999).

Hassenzahl argues that user experience is a combination of these two perspectives. It is a result of a user's internal state (mood, motivation, needs etc.), the product's characteristics (usability, functionality, purpose) and the environment in which the interaction occurs (setting, reason for use, etc.) (Hassenzahl & Tractinsky, 2006). This definition suggests that for a product to provide a good user experience, it must also accommodate good usability. Likewise, it also suggests that poor usability can cause a poor user experience (McNamara & Kirakowski, 2006).

2.3 Usability

As mentioned earlier, one of the concerns of interaction designers is to ensure that their product has good usability. Usability can be described as:

"A quality attribute relating to how easy something is to use. More specifically, it refers to how quickly people can learn to use something, how efficient they are while using it, how memorable it is, how error-prone it is, and how much users like using it." (Nielsen & Loranger, 2006)

In simplicity, what makes something usable is that there are no problems using it. *"When a products is truly usable, the user can do what he or she wants to do the way he or she expects to be able to do it, without hindrance, hesitation, or questions"* (Rubin & Chisnell, 2008). In other words, a product with relatively good usability is a product that allows the user to effortlessly complete his/her intended tasks without unnecessary digressions.

2.3.1 Usability goals

There are certain universal usability goals that designers should follow to ensure that their product will be truly usable. The product should be *effective to use*, *efficient to use*, *safe to use*, *have good utility*, *easy to learn*, and *easy to remember* (Preece et al., 2007). These goals are listed in more detail:

- **Effectiveness** - Refers to how well a product does what it is supposed to do. It should help a user complete his/her tasks as quickly and effortlessly as possible.
- **Efficiency** - Refers to how well the product supports the user in completing his/her tasks and how quickly it can be completed.
- **Safety** - This involves protecting the user from undesirable situations, such as error messages and recovering from unwanted actions.
- **Good utility** - It focuses on how well the product provides the user with the right functionalities to do their tasks.
- **Learnability** - Refers to how easy a product is to learn. People do not like to spend time on learning new systems, thus learnability is important.
- **Rememberability** - Concerned with how easily one can recall how to use a product. This is especially important with products that are not used daily, but rather infrequently.

The difference between the usability goals effectiveness, efficiency, and utility may be ambiguous. Their difference is more easily distinguished with an example. Considering three very simple phones, the first one only has classical calling functionality, the second one additionally has a contact list, while the third one supports calling and sending short text messages. All three phones are equally *effective* in placing a call, but the second one is more *efficient* since it helps users to place calls by remembering phone numbers. The third phone on the other hand has comparatively better *utility* as it additionally supports communication through text messaging.

2.3.2 Design principles

Design principles are intended to help designers think about different aspects of their design (Preece et al., 2007) (Apple Corporation, Inc., 1993). The following is a list of design principles originally introduced by Norman (Norman, 1988).

2.3.2.1 Visibility

"*Visibility indicates the mapping between intended actions and actual operations.*" (Norman, 1988). In other words, it means that not only must a system's functionality be visible, but those functions must correspond with the appropriate visual clues, i.e. have good mapping. Visibility is linked to affordance in the sense that good visibility helps create good affordance, therefore in increasing a system's learnability and ease of use, good visibility is required (Chen, 2001). In contrast, if the functionalities were *invisible*, the user would be forced to remember the available features, which would negatively impact the usability (Carayon, 2011).

2.3.2.2 Affordance

The term *affordance* refers to the product's expression of its actual and perceived properties and its potential use (Bærentsen & Trettvik, 2002). Norman describes that an object (or interface) has good affordance if it provides strong clues of its operation and functions. While those clues can be advertised with good feedback, visibility, constraints, etc., those clues are independent of the concept of affordance. Affordance is the effect those clues may have on the user (Norman, 1999). When they are facilitated or *"when affordances are taken advantage of, the user knows what to do just by looking."* (Norman, 1988). Providing good affordance increases a systems learnability and ease of use (Cairns & Thimbleby, 2008), in addition to improving the application's intuitiveness, i.e. it reduces the user's cognitive load (Naumann et al., 2007).

The concept of affordance was originally introduced with the more descriptive term: the *stimulus-response compatibility* (Hommel & Prinz, 1997). It has been argued that the physical affordances of tangible user interfaces provides good intuitiveness as a result of its similarity to peoples´ experience with the real physical world, hence allowing them to take advantage of their existing skills (Jacob et al., 2007). However, another study suggests that physical affordances may be misleading in many cases as they may afford actions that are not supported by the system, hence the system becomes less safe to use (Hornecker, 2007). Gaver refers to this as *false affordance*, which is an affordance that affords non-existent actions (Gaver, 1991).

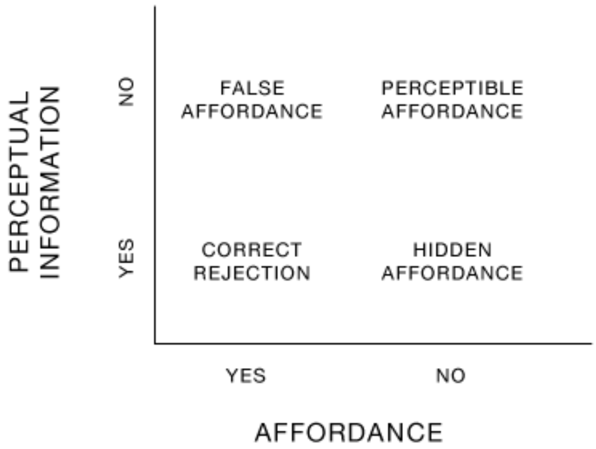

Figure 1: Different forms of affordance. (Gaver, 1991, p.80)

Gaver distinguishes between four types of affordances, including *false affordance*. *Perceptible affordance* is when there is perceptual information available for an existing affordance. *Hidden affordance* refers to the lack of information available about an affordance, thus the affordance must be derived from elsewhere. *Correct rejection* means that a user experiences no affordance for an action when there in fact is none (Gaver, 1991).

2.3.2.3 Mapping

The term mapping refers to the relationship between a control and its effect (Preece et al., 2002). The concept describes that functionality should logically map to the actions required by the user to cause a logical effect. Norman described that the mapping should be *"[…] easily learned and always remembered"* (Norman, 1988). Xinyuan states that a mapping should be intuitive to use and easy to learn (Xinyuan, 2009). In addition, he mentions the *natural principle*, a principle in game design that argues that when designing input sources, one should take the user´s physical and mental habits into consideration. According to the principle, the human-computer interaction in a game should correspond to a user´s cognitive habits and life experiences, as the user more quickly will integrate into the virtual environment. According to this, it would be reasonable to assume that systems that rely on embodied interaction[1] can provide good mapping as people´s motor skills are automatized and do not require any cognitive load.

2.3.2.4 Feedback

When communicating, people expect the person they are conversing with to provide some indication of understanding through verbal language, gestures, or body language. Not only is this feedback important in human-human interaction, but in the interaction between human and computers as well. This idea of communication expectation is called *"psychological closure"*, and is a common human characteristic that should be accounted for when designing interfaces (Simes & Sirsky, 1985).

Shneiderman *et, al.* refers to feedback as a system's act of communicating the result of a user's actions (Shneiderman & Plaisant, 2005). They argue that for every action a user performs, there should be an appropriate system response. Feedback should be applied to any design to keep the user informed on their action's status, either in auditory form, visual form, tactile form or a combination of these forms (Apple Corporation, Inc., 1993). If appropriate feedback has been provided, a user should have sufficient information to complete his tasks both efficiently and effectively (Love, 2005), in addition to enhancing the visibility of user actions (Preece et al., 2002).

Pallotta *et, al.* argues that a different amount of feedback should be provided to users of a KUI compared to desktop interfaces (Pallotta et al., 2006). According to them, a KUI should avoid distracting the user´s current activity,

[1] Please see section 2.6 for the definition of this term.

hence only a minimal amount of information about the user being recognized should be provided to him or her.

2.3.2.5 Consistency

This principle encourages designers to design systems that use operations and elements that are similar to other systems. The benefit is that such systems are easier to learn and use (Preece et al., 2007). If an interface meets the user´s expectations, it enhances the system´s learnability (Love, 2005). Users also tend to make fewer errors if an interface is consistent with its peers (Ozok & Salvendy, 2000). Research shows that providing good consistency can increase user satisfaction as well as reduce task completion time (Koyani et al., 2004). If the system were inconsistent, the user would be distracted as well as forced to remember how to conduct different tasks, hence reducing learnability and causing confusion (Galitz, 2007).

2.3.2.6 Constraints

A system should constrain the set of possible actions to what is relevant given the context. Norman divides constraints into three categories; *physical constraints*, *logical constrains* and *cultural constraints*. *Physical constraints* rely on physical properties restricting the user's actions. For example, a cursor cannot be moved outside of the screen, which is a physical constraint. *Logical constraints* rely on the user's logical understanding of the way the world works, and cultural constraints rely on learned conventions (Preece et al., 2007) (Norman, 1988). Furthermore, logical constraints are useful in enhancing the user's understanding of the environment he is interacting with. They guide a user's behavior, for example which screens that are available, where he/she can scroll, and when tasks are completed (Norman, 1999). *Cultural constraints* are based on learned conventions. An example is the scrollbar on the right side of the screen, which people know can be dragged up or down.

2.3.3 Summary

In summary, this section has introduced the following design principles, originally introduced by Norman: visibility, affordance, mapping, feedback, consistency, and constraints. These design principles are intended to help in designing products with good usability.

2.4 Four approaches to interaction design

According to Saffer, there are four different approaches that a designer can choose between when designing a product. In many cases, designers tend to follow the one they feel most comfortable with, but choosing the most appropriate approach is still important and can often differentiate good designers from great ones. These four approaches are as follows: *Activity-centered design, Systems design, Genius design and User-centered design* (Saffer, 2007).

Activity-centered design's main concern is the user's activities (Saffer, 2007). Similarly to User-centered design, it relies on research, but more so on user behavior rather than user goals. Its primary concern is how the user behaves when he/she performs different activities. By observing these activities, the designer can help improve the user´s performance by designing solutions that supports these activities. Systems design is another approach that is quite different from the ones previously mentioned. Its concern lies on the broad context of which a product is being used, and favors this context over the user. It involves less guesstimating, and provides the designer with a clear understanding of what the system should provide. The fourth approach is genius design. In genius design, the designer is in the driver's seat. User involvement is close to non-existent, hence there is no user research phase and design decisions are based purely on the designer´s judgment and experience (Hawley, 2009). This approach is often chosen due to insufficient recourses, as involving users costs time and money.

2.4.1 User-centered design (UCD)

User centered design is about products adapting to people by making the user the center of attention (Saffer, 2007). This philosophy seeks to support users in doing their work by making the design adapt to the user instead of the other way around (Rubin & Chisnell, 2008). As it is difficult for designers to beforehand foresee how a user will react to a product or how he/she will use it, a wise approach is to involve them in all stages of a design process to ensure more efficient, effective, and successful products (Preece et al., 2002).

2.5 User interfaces

To better understand the term Kinetic User Interface, this thesis will also provide a brief overview of some of the other interfaces that are available today. This thesis will avoid using the problematic terms natural user interface (NUI) and graphical user interface (GUI) due to their elasticity (Norman, 2010), and will instead distinguish between various forms of these interfaces.

2.5.1 Desktop interface

A desktop interface is an interface where the user interacts with the system through the use of a monitor, keyboard, and a mouse (Preece et al., 2007). However, due to the emergence of new types of interfaces such as multi-touch, tangible user interfaces, and so on, people tend to refer to desktop interfaces as synonymous to graphical user interfaces. According to Memon, *et, al*., a graphical user interface (GUI) is an interface with highly visual controls such as menus, buttons, lists, and windows (Memon et al., 2003). Considering that all of the interfaces mentioned during this chapter rely on a user interacting with visual controls on a screen (often with elements such as menus, buttons, lists, and windows), through the use of e.g. spatial gestures or physical touches, this thesis find the word GUI too elastic and will instead use the more specific terms: desktop interface, multi-touch interface, etc.

2.5.2 Multi-touch interface

A multi-touch interface is an interface that supports interaction with the system through multiple contact points simultaneously (Jefferson, 2005). As a result, users are able to interact with finger-gestures directly on the display surface. It does not only accommodate for multiple user interaction, but it also provides a more direct way of communicating with digital content (Izadi et al., 2007).

2.5.3 Proximal user interface

Norman states, "the real problem with the interface, is that it is an interface" (Norman, 1990). He suggests that interfaces tend to steal focus away from the user´s intended job as more effort is put into operating the interface itself. With conventional user interfaces like the desktop interface, the user has to communicate with system through clicking a mouse or a keyboard, actions which can consume the user's attention. A proximal user interface (PUI) on the other hand, is an interface which is supposed to be so natural in a way that it does not draw such attention from the user as it is ”less in the way” (Jacko & Constantine, 2003). If an interface becomes ”proximal”, it will less likely interrupt a user´s attention and flow of thinking within a task (Basden

& Hibberd, 1996). Hence, to design a PUI, the interface´s usability is of earnest consideration.

2.5.4 Tangible user interfaces

Tangible interaction is a term that has gained popularity within the field of interaction design in the recent years. Tangible interaction encompasses systems that rely on embodied interaction through physical manipulation of tangible representation of data (Hornecker & Buu, 2006). Interfaces that enable tangible interaction are called tangible user interfaces (TUI) and they take advantage of people´s motor, spatial and social skills gained by interacting with the real world (Jacob et al., 2008). In 1997, an article presented TUI as an alternative to the traditional desktop as we know it (Ishii & Ullmer, 1997). The article argued that the use of tangible objects would create a richer multi-sensory experience of the digital information than one would otherwise. A good example of a tangible user interface is the "Marble Answering Machine" (Preece et al., 2007).

2.5.5 Kinetic user interfaces

Figure 2: Examples of Kinetic User Interfaces – Nintendo Wii (left) and Microsoft Kinect (right)

During the recent years there has been an emergence of devices that take use of embodiment to interact with computing devices. Even though the technology has been around for quite some time, it has not been available to the public until recently. In 2006, the Nintendo Wii[2] was released followed by the PlayStation Move[3], and then the Microsoft Kinect[4] in 2010. The Wii and Move both have controllers that are equipped with an accelerometer. This allows the controller to be tracked in 3D-space, which enables the user to interact with the digital environment simply by moving the controller. Similarly, the Kinect also captures body movement, but without the need of any additional controllers. It uses a depth camera, an infrared camera and a RGB camera that it combines to track a user's movements. It can deduce the location and orientation of every major joint in the user's body thirty times per second.

These types of interfaces have been given many different names, such as natural user interfaces (Jihlmil et al., 2011), embodied user interfaces (Fishkin et al., 2000) and kinetic user interfaces (KUI) (Pallotta et al., 2006).

Since the term NUI has become quite popular for describing several different gestural interfaces such as multi-touch surfaces and tangible surfaces, this thesis finds the term too broad and elastic for the study of spatial movement based interfaces. In addition, Norman argues that NUI´s are actually not natural, since most gestures are neither natural nor easy to learn and remember (Norman, 2010). As a result, this thesis prefers the term KUI as it was found the most appropriate for the project's purposes. Pallotta, *et al.* defines a KUI as an interface that through physical motion in an environment determines the functions to be executed. A user of a KUI can trigger computational events simply by moving his/her body, somewhat similarly to

[2] http://www.nintendo.com/wii

[3] http://us.playstation.com/ps3/playstation-move/

[4] http://www.xbox.com/en-US/kinect

moving a mouse on a desktop. Since it can understand the user's entire body as an input modality, it facilitates richer interactions than one would achieve with a desktop interface.

2.6 Embodied interaction

Embodied interaction is based on the philosophical and psychological position called *embodied cognition*. In contrast to Cartesian approaches, embodied cognition is a viewpoint that considers the nature of the human mind (its cognitive processes) to be deeply rooted and related with the human body's interaction with the physical world (Wilson, 2002). Paul Dourish explains that since humans are naturally familiar with the real physical world, designers need to incorporate that "real-world-ness" into the interfaces, not simply with metaphors (buttons, windows, etc.), but more deeply than that. He explains that embodied interaction is much more than just brining real world metaphors into interfaces. It is also more than just relying on the user being physically active to increase engagement. It is about creating "*a relationship between action and meaning*", and some methods for creating that relationship may perhaps be to incorporate real world metaphors into interfaces, or to create interfaces that require physical movements from the user (Dourish, 2001). The nature of the KUI strengthens that relationship as such an interface allows more comprehensive user actions, more cognitive processes can be utilized; hence it gains a stronger meaning with the user. The following outlines some of the relationships between embodied interaction, usability, and UX.

Multiple studies have found correlations between a person's movements and postures and their subsequent emotions, motivations and self-efficacy[5]

[5] For more about self-efficacy, please see 2.8

(Bloom et al., 2008) (Riskind & Gotay, 1982). Not only does embodied interaction improve the user's engagement (Bianchi-Berthouze et al., 2007), but studies have also shown direct correlation between improved rememberability and embodied cognition (Scott et al., 2001). In other words, interfaces that encourage the user to be physically active may improve the user's rememberability. In contrast, interfaces that restrict the user to a small set of gestures, e.g. a keyboard, tend to hinder the user's communication and thinking. However, less physically constraining interfaces are more likely to promote such cognitive processes (Klemmer et al., 2006).

2.6.1 Exergames

Exergames is a category of applications that utilizes the advantageous aspects of embodied interaction to persuade users to be physically active (Hansen & Sanders, 2008). Exergames are videogames, that utilizes body movement to interact with digital environments, thus, encouraging a user to exercise while gaming (Yang et al., 2008). Several studies have shown that certain exergames can actually motivate sedentary users to exercise (Graf et al., 2009) (Graves et al., 2008), which to a degree, attests the relationship between embodied interaction and engagement.

2.7 Motivation

Motivation is a psychological construct that constitutes the aspects of activation and intention, such as energy, persistence and direction. A person who feels the need to act and is energized towards an end is considered to be motivated; he or she is moved to do something. Likewise, a person who feels no impetus or will to act is categorized as amotivated.

Although the concept of motivation is interesting with respect to a psychological standpoint, its significance is obvious in the real world; “motivation produces” (Ryan & Deci, 2000). People who are motivated are more likely to be productive and accomplishing, hence it is cardinal for educators, managers, and health care providers to understand motivating factors. Furthermore, one must consider that performance varies with different forms and types of motivation (Ryan & Deci, 2000).

As research into the concept of motivation has progressed it is apparent that people not only have different *levels* of motivation but also different *orientations* of motivation, i.e. different types of motivation. Orientation of motivation describes the causes and goals behind one’s actions. The most basic distinction between the causes is divided into two groups: *intrinsic* motivation and *extrinsic* motivation (Ryan & Deci, 2000).

2.7.1 Intrinsic and extrinsic motivation

Intrinsic motivation is one’s will to be active, inquisitive, explorative and curious in the absence of a specific reward. It is the most self-determined form of motivation as it is observed and acknowledged by developmentalists while studying children as they unsolicitedly seek out novelty and challenges. It has also been described as the phenomenon that reflects the most positive potential of human nature (Harter, 1978).

Some theories credit all behaviors and willingness to act as a means for acquiring a reward. In the case for intrinsically motivated acts, the act itself is the reward, as opposed to some unrelated benefit or pressure. For *extrinsically* motivated acts, the act is a means for acquiring a separate goal. Hence *extrinsic motivation* has been described as the will to act to attain an unrelated outcome (Ryan & Deci, 2000).

A person who is intrinsically motivated may perform an action because the action itself is enjoyable, while someone who is extrinsically motivated either regards the action as a means to accomplish something unrelated or is pressured, either externally or internally, to perform said action. Furthermore, it has been shown that people who are motivated intrinsically show more interest, excitement and confidence than people who are pressured by external factors (a subset of extrinsically motivating factors). This observation is even true when people from both groups have the same confidence for the activity. Additionally, studies have shown that increased interest, excitement and confidence for an activity tend to increase one's performance, persistence and enjoyment for said activity (Ryan & Deci, 2000). Hence it is apt to explore the factors that induce the different orientations of motivation.

In the context of interaction design one can divide the users of an application into two main groups. Those who use the application to obtain an unrelated separate goal can be considered extrinsically motivated, and those who find enjoyment in the challenges or usage of an application are intrinsically motivated (Smyslova & Voiskounsky, 2009).

In the context of this thesis, it is interesting to note that research has found that children's motivation for participating in physical activity tend to be credited to intrinsic motivation as opposed to extrinsic motivation (Mandigo & Thompson, 1998). This suggests that it is important to attempt to encourage children to become intrinsically motivated to exercise instead of focusing on extrinsic aspects, such as pressure, external rewards and so on.

2.7.2 Self-determination theory

By studying intrinsic and extrinsic motivation, Ryan and Deci developed and introduced the Self-Determination Theory (SDT) in the mid-80s. The theory attempts to describe people's motivation behind choices and behaviors. It has been studied, as well as used, extensively in the fields of education, management, and health care (Ryan & Deci, 2000).

Included in the SDT, Ryan and Deci have identified three inherent needs for the basis for self-motivation, personal growth, confidence and other conditions that foster intrinsic motivation as well as transforming extrinsic motivation into intrinsic motivation. Those three essential needs are *competence*, *autonomy,* and *relatedness* (Ryan & Deci, 2000).

The feeling of competence refers to the subjective feeling of being able. As an example, someone feels competent when they are able to overcome a challenge. It is the innate desire to improve one's ability at a certain task. The feeling of autonomy is the experience that one's behavior is voluntary and self-endorsed. Finally, relatedness is the desire to feel positive social connection to others. Baumeister and Leary, in addition to Ryan and Deci, explained relatedness as a fundamental need to be loved and cared for. SDT proposes that a situation where these three needs are satisfied (not necessarily all simultaneously) can not only increase intrinsic motivation, but also convert some forms of extrinsic motivation into not only intrinsic motivation but also some types of extrinsic motivation that are more similar to intrinsic motivation (Ryan & Niemiec, 2009).

SDT argues that social-contextual events, such as positive verbal feedback, can enhance a person's feeling of competence. However, the theory further describes that a feeling of increased competence alone is not enough to increase a person's intrinsic motivation for a task. It must be accompanied with a feeling of autonomy. In other words, a person must perceive that their gained competence is a result of self-determined and voluntary behavior (Ryan & Deci, 2000).

While the significance of competence and autonomy is evident in the induction of intrinsic motivation, psychological theorists are debating the importance of relatedness. A study showed that if infants performed a task they were originally intrinsically motivated to do in the presence of an ignoring and dismissive adult stranger, their intrinsic motivation not only dropped, but also dropped to a very low level (Anderson et al., 1976). Similarly, another study done by Ryan and Grolnik found the same results while observing students in the presence of uncaring teachers (Ryan & Grolnick, 1986), which suggests this effect is not restricted to merely infants. However, considering that many perform intrinsically motivated tasks in isolation, one must concede that relatedness, although is of importance, is nonetheless not essential for intrinsic motivation. Nevertheless, these studies show that a negative experience of relatedness can be destructive (Ryan & Deci, 2000).

Additionally in describing the needs for intrinsic motivation, SDT also addresses extrinsic motivation. While the causes for intrinsic motivation are only internal, extrinsic motivation needs to be divided into several sub-categories, from most non-self-determined to most self-determined; perceived *external causality*, perceived *somewhat external causality*, perceived *somewhat internal causality* and perceived *internal causality*. For example, consider someone who performs an action due to external pressure and someone who performs an action for a separate internal goal. Although their motivations are evidently different, both their motivations are categorized as extrinsic, specifically external extrinsic and (somewhat) internal extrinsic respectively. For extrinsically motivated people the task is merely a means of achieving a detached goal, in contrast to intrinsically motivated people. Furthermore, SDT also explains that the more internally caused a motivation is, the more self-determined and autonomous a person feels, which evidently morphs their orientation of motivation towards the direction of intrinsic motivation (Ryan & Deci, 2000).

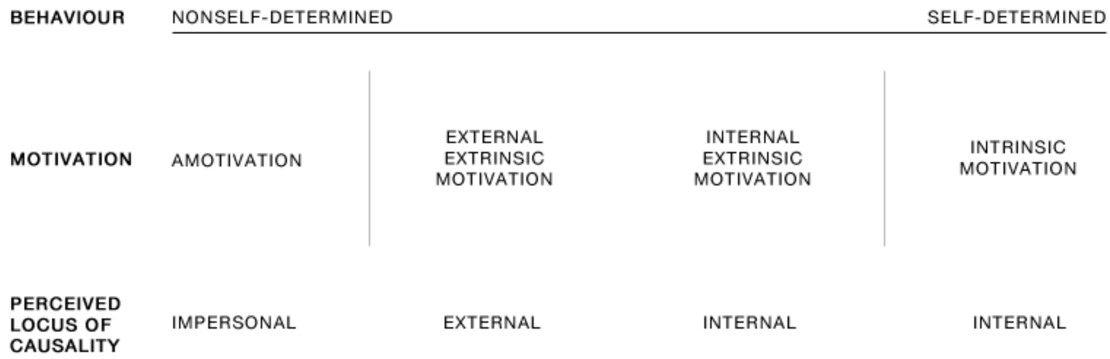

Figure 3: Taxonomy of motivation in Self Determination Theory. (Ryan & Deci, 2000, p.72)

In the context of motivating people to conduct physical activity one must consider the orientations of people's motivations and attempt to facilitate the more appropriate ones. In a study by Wood and Bandura, it was found that people extrinsically motivated by external and somewhat external causes (non-self-determined) performed worse than those motivated by internal and somewhat internal causes (self-determined). The latter group not only performed better, but also was more likely to persist longer than requested. In addition, their confidence increased and they were more willing to set themselves higher goals. This characteristic is referred to higher *self-efficacy* (see section 2.8) (Wood & Bandura, 1989) (Kavussanu & Roberts, 1996). Thus, in order to facilitate self-determined motivation (intrinsic motivation and more internally caused extrinsic motivation), the person needs to experience competence in the activity as well as autonomy, and potentially relatedness as well.

Furthermore, a meta-analysis by Deci, *et al.* found that the effect of exposing intrinsically motivated people to external tangible rewards was found to be destructive to intrinsic motivation as it transforms it into extrinsic motivation. The same applies for other externally extrinsic motivational factors, such as external pressure, deadlines, threats, etc. all seem to diminish intrinsic motivation. In other words, non-self-determined motivation is destructive to self-determined motivation. SDT explains the reason for this effect is that external factors undermine autonomy, which is essential for intrinsic motivation, and also necessary to maintain internal extrinsic motivation. Therefore, one must be cautious when using external motivating factors. Although those factors may cause non-self-determined (external extrinsic) motivation, they will be destructive for self-determined motivation (i.e. internal extrinsic motivation as well as intrinsic motivation) (Ryan & Deci, 2000).

Although theories in motivational psychology present various characteristics for describing different forms and categories of motivation, it is important to note that those categorizations are not rigid or fixed. It is a continuum from one category to the next, which means that although someone might be categorized as internal extrinsically motivated, it does not mean that that person's motivation is purely internal extrinsic. He or she may experience intrinsic motivation or external extrinsic motivation in addition, but to comparatively lesser extents. Furthermore, it is also interesting to note that although these categories are aligned along a continuum, SDT does not state that one person must move along that continuum to change from one category to another, only that the neighboring categories share similarities. For example, a person who is amotivated does not have to first experience non-self-determined motivation before experiencing self-determined motivation. If the conditions are sufficient, he or she might simply jump from amotivation to self-determined motivation, skipping non-self-determined motivation (Ryan & Deci, 2000).

2.8 Self-efficacy

Self-efficacy is, in brief terms, defined as a person's perception of their ability to control the events in their lives in the form of tackling challenges. It is closely related to confidence. Each person has various degrees of self-efficacy, and the degrees frequently fluctuate based on challenges and one's ability to surmount them (Bandura, 2004).

People with high self-efficacy are in general motivated and expect positive outcome from the events in their lives. These types of people set personal goals that they believe are achievable. In contrary, people with low self-efficacy have little belief in positive results from events in their lives, hence they tend to view challenges as insurmountable. Thus, people with low self-efficacy may require additional motivating factors to start and maintain something that is perceived as difficult, for example an exercise program (Graham, 2007). Such factors may also increase self-efficacy.

A study by Mitchell, *et al.* showed that ¾ of those who dropped out of a weight-loss exercise program could be categorized with low self-efficacy, and ⅔ of those who continued could be categorized with high self-efficacy. In addition, their study also showed that prior to people quitting the exercise program they achieved the same objective results as those who continued, which in turn implies that those with low self-efficacy tend to quit based on their own assessment of their results rather than an objective analysis (Mitchell & Stuart, 1984). Thus, the importance of motivating people with low self-efficacy is evident.

Self-efficacy is not only closely related to the orientation of motivation but also the cause of motivation, specifically non-self-determined motivation (extrinsic). Based on the previously mentioned study done by Wood & Bandura, the correlation between the probability of discontinuing an exercise program and their low self-efficacy and the correlation between low self-efficacy and non-self-determined motivation, one can argue that if someone's motivation for continuing an exercise program is caused externally, there is a higher chance that they will quit than those who are motivated by internal causes. Likewise, considering that the majority of those who continued the exercise program in the study by Mitchell, *et al.* were categorized with high self-efficacy, and the correlation between high self-efficacy and internally caused self-determined motivation (both intrinsic and internal extrinsic), one can conclude that those who are self-determinedly motivated to conduct physical activity are more likely to perform better and persist longer than those who are non-self-determinedly motivated. This correlation is also supported by many studies that found that duration, frequency and intensity of exercise was unrelated, or even negatively related, to non-self-determined motivational factors. Furthermore, people who exercised due to self-determined motivational factors were more likely to exercise longer, more frequently and experienced a higher degree of self-efficacy (Ryan et al., 1997) (Vansteenkiste et al., 2007).

Therefore, to encourage a person to start and maintain an exercise program it is reasonable to focus on facilitating the factors that create self-determined motivation (internal extrinsic and intrinsic) to stimulate self-efficacy. Additionally, to continuously stimulate self-efficacy one needs to balance the difficulty of challenges (in this context; various exercise activities) with the subject's skill level. A theory that describes this balance is called *Flow theory*. (See section 2.9)

2.9 Flow theory

Flow theory describes eight different mental states a person can experience while tackling a challenge. Csikszentmihalyi, who many regard as the founder of Flow theory, described the ideal mental state, the *flow*-state, as the "*holistic sensation people feel when they act with total involvement (in an activity)*" (Kowal & Fortier, 1999, p.356). People in this state have devoted their consciousness fully to the activity and have lost awareness of their surroundings and basic bodily functions. They are fully immersed and engrossed by the activity itself. The sensation of performing the activity itself becomes the motivating factor for continuing the activity; hence intrinsic motivation for the activity is created. Additionally the person's self-efficacy increases, as the challenge level is optimal for his or her skill level (Csikszentmihalyi, 1975) (Csikszentmihalyi et al., 2005).

Considering that there is an upper limit of the amount of information a person can process simultaneously, a person experiencing flow is so focused on tackling the challenges at hand that no processing ability is left available for unrelated aspects, such as time, bodily functions, their surroundings, etc. Miller actually managed to estimate the human brain's processing capability to approximately 126 bits per second (Miller, 1956). To put that number in perspective, the estimate on the processing required for maintaining a conversation is around 40 bits per second (Csikszentmihalyi, 1988).

The flow-state occurs when the following conditions are satisfied; 1) there is a *clear set of goals*, 2) there is an *ideal balance between challenge and skill level*, and 3) the presence of *clear and immediate feedback*. In other words, a state where the goal of the task is clearly defined, the task is both highly challenging and one's skill level are of a comparatively similar level, and finally the feedback provided is immediate, correspondent and indicative of course of action (Csikszentmihalyi, 1975) (Csikszentmihalyi et al., 2005).

If the challenge level is sub-optimal, for example if there is a mismatch between the perceived challenges and skill level, or if the goals are not clearly defined or the feedback is non-immediate or non-correspondent with the task at hand, then a person will not experience flow. A mental state of *worry, anxiety* or *arousal* can be experienced if the challenges are higher than the skill level, and mental state of *boredom*, *relaxation* or *control* can be experienced if the vice versa is the case. Finally, if both the challenge and skill level are low, a feeling of *apathy* is likely to occur (Csikszentmihalyi, 1990) (Csikszentmihalyi, 1997).

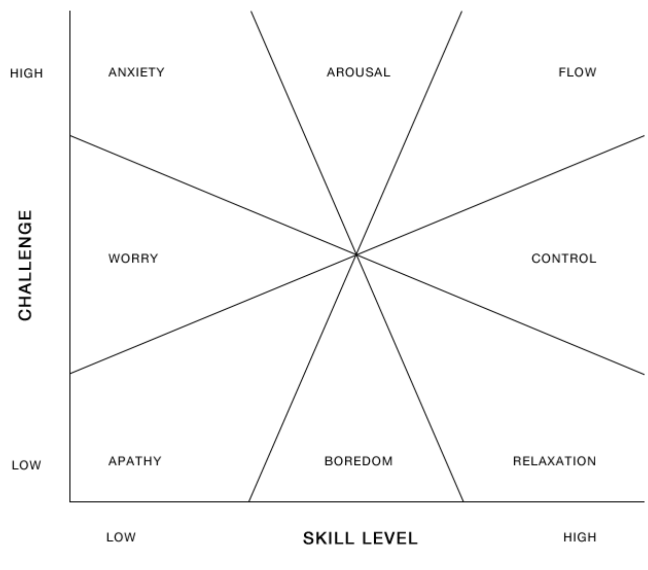

Figure 4: Challenge and skill level diagram. (Csikszentmihalyi, 1997, p.31)

The flow state has also been linked with motivational determinants. It has been found that those who exercise due to self-determined causes (i.e. either internal extrinsic motivation or intrinsic motivation) experienced a greater frequency of the flow state than those who were motived by non-self-determined motivation (external extrinsic). This suggests that self-determined motivation can facilitate flow, while non-self-determined motivation might inhibit it. These observations indicate the importance of facilitating self-determined motivation, which Kowal & Fortier further suggests can be induced by accommodating the three inherent needs presented by the SDT; competence, autonomy and relatedness (Kowal & Fortier, 1999).

Considering the interlinked relationship between self-determined motivation, self-efficacy and flow, it is apparent that by inducing self-determined motivation it causes a person's self-efficacy and likelihood of experiencing flow to increase. In the context of this thesis, it entails that to encourage a person to start and maintain an exercise program, it is reasonable to consider and facilitate self-determined motivation, self-efficacy, and flow.

2.10 Summary

In summary there are many aspects that needs to be considered when designing applications. Since psychology is an integral part of interaction design, this thesis will also consider the requirements introduced by motivation psychology in addition to the aspects presented by usability guidelines, design principles, and user experience.

3 Methods

This section describes the various research methods relevant to this project. The thesis will first introduce them generally, discuss their applicability and relevance, and then explain why they were chosen and, if relevant, how they were adapted to suit the thesis' purpose. The Case chapter includes more comprehensive details on how the methods were implemented.

The first sub-section outlines the differences and similarities between the two main categories of research methods. It will then explain why this thesis chose to primarily focus on research methods within one category. The following sub-sections each describe a different phase of the project lifecycle. Specific research methods are included within each of these sub-sections.

3.1 Qualitative and quantitative research methods

The success or failure of an interaction design project is ultimately decided by how well it suits the needs of both the end-users as well as the other stakeholders. To increase the chance of success, the designers must gain comprehensive knowledge about the users and their uses. While designers can deduce some knowledge from quantitative studies, the "deep" comprehensive knowledge about the user is most effectively obtained from qualitative methods (Cooper et al., 2007). While many fields of science regard quantitative results as the most accurate type of data, research fields studying human activities and experiences, such as the field of interaction design, have often found such methods to be too simplistic for understanding all the nuances of human behavior (Cooper et al., 2007). Additionally, considering that quantitative methods for data gathering are most suitable for measurable comparative studies (Nielsen, 2008), qualitative data gathering methods will instead be prioritized for this project.

3.2 Understanding users and uses

The first step of most interaction design projects is to attempt to better understand both the problem domain as well as the target user group. This phase is sometimes referred to as design research (Preece et al., 2002). In order to gain a better understanding of the problem domain this thesis will review a subset of the plethora of published literature and studies in the related fields. To acquire a better understanding of the technology and the target group, their usage patterns and motivations, this project will use and combine some existing research methods.

In addition to literature review, this thesis will attempt to gather original data about the problem domain and users. Selecting an appropriate data-gathering method to investigate a target group's behaviors, motivations, and goals is paramount to the outcome of the results. Hence, this thesis briefly evaluates self-reporting methods such as journals against observational methods, interviews and questionnaires.

Interviews and questionnaires are relatively easy to conduct and they also provide a lot of relevant data. However, it has been shown that the results are easily influenced by a plethora of external aspects (Saffer, 2007) (Nielsen, 2010). One aspect that requires consideration is that the participants are asked about events, mind-states or thoughts some time after they occurred, and considering the fragile nature of human memory, the data gathered may be fallacious (Magnussen, 2007). Another aspect is that participants tend to provide the "ideal" or "correct" answer instead of the actual truth, something that seems very likely when questioned about exercise and motivation (Mazar et al., 2008). A third aspect is that the processes of interviewing or filling out a questionnaire are imperfect as many external aspects, such as setting or social atmosphere, may influence the participant's cognitive processes, hence the results (Nunkoosing, 2005). While journals may share some of the weaknesses of interviews, its advantage of being able to collect data over longer periods of time makes it more preferable.

Other possible methods this thesis has evaluated as less preferable to journals include e.g. observation and focus groups. Observations are very difficult and time consuming to conduct (Preece et al., 2002), and considering the application for this project, the act of observing the participants before, after, and during exercising would most likely influence the results. A focus group method is a form of group interview, something Saffer strongly discourages as group dynamics might influence the results (Saffer, 2007).

3.2.1 Journals and cultural probes

The use of journals is a simple and cheap method for tracking users activities as they record what the users did, when they did it, what they thought when they did it, and so on. This method is especially appropriate when the project needs to track the users' activities consistently over longer periods of time with as little interference as possible. It is also advantageous since the method does not require specific geographical locations of the participants. However, for the method to function properly the participants need to be devoted and record data consistently and adequately. Therefore, it is essential to make the task of writing in the journal as easy and effortless as possible for the users. Furthermore, it might sometimes be necessary to provide additional incentives to assure participant dedication (Preece et al., 2002).

The purpose of cultural probes lies inherent in its name; it is a method to probe into a target group's culture with the least amount of interference. Cultural probes are not intended for communicating ideas, testing concepts or identifying user needs, but instead to gain an understanding of the users in their natural environment over a longer period of time. Hence, they are most appropriate during the early stages of an interaction design project (McDougall & Fels, 2010) (Gaffney, 2006). However, since cultural probes are only intended for "eliciting inspirational responses from people" and gathering "fragmentary clues about their lives and thoughts" instead of being analyzed and summarized for requirements or generalized, their applicability is rather selective (Gaver et al., 2004).

Cultural probes are conducted in a very similar way as journals. They are often a physical package of novel tasks and distributed to the participants. The participants are instructed to complete a task either before or after a specific event or regularly during the study (Preece et al., 2002). Hence, it is fairly easy to combine aspects of cultural probes with journals by incorporating creative/novel tasks in a journal to attempt to increase participant dedication and accuracy of the collected data.

Journals and cultural probes are both methods that have been used extensively in the field of interaction design (Preece et al., 2002).

In attempt to gain a better understanding of the problem domain and the users this thesis chose to use journals for collecting data about users' exercise habits instead of other data-collection methods, such as interviews, questionnaires and observation. To make writing in the journals as easy and effortless as possible for the participants, to increase the probability of consistent devotion, this thesis finds it appropriate to draw inspiration from the novel and creative format of cultural probes by incorporating playful and simple tasks in the journals.

3.3 Data analysis

In order to extract knowledge from the methods aimed at gathering data about the users and their uses, one can use more systematic approaches. This section introduces one such approach called *personas*.

3.3.1 Personas

One way of summarizing the preliminary results from researching the target users and the problem domain is to formulate and group common traits and findings into fictitious user profiles called *personas*.

One advantage of this method is that since the user profiles (personas) are created based on research relevant to the project, it will continually remind the designers to consider every type of user and use. It reminds the designers of various user goals, behaviors, and motivations throughout the design process. Instead of designing for an ill-defined user, the designers can instead be reminded that they are designing for many specific users. Additionally, the creator of this method, Alan Cooper, discovered that if the conducted research were not formulated into an explicit format, such as user profiles, it was easy for every designer to develop their own unique understanding of the user group. This sometimes caused designers to use their subjective understanding of the users to serve any purpose. Cooper created the term "The Elastic User" to describe this tendency. Furthermore, by continually reminding the designers of every relevant user type it is less likely for designers to only focus on some and forget other user types (Cooper, 2004) (Preece et al., 2002) (Saffer, 2007).

Personas are representations and generalizations of a user segment packaged into fictitious profiles. To make the fictitious profiles believable the description includes basic information such as a name, a profile picture and a veneer of demographic data in addition to goals, behaviors and motivations. However, the characteristics differentiating each persona are based on what users do and why they do them, i.e. the users' actions, their motivations and goals, and not demographics. Since demographic data does not describe neither actions nor motivations and goals, differentiating based on those characteristics may create excessive personas. However, in cases where different usage patterns are caused by demographical aspects it may be necessary to differentiate personas based on those characteristics, only if it is problematic to describe the difference in other terms (Saffer, 2007). Cooper also underlines that while the details necessary to make a persona believable are fictitious, the persona's motivations, goals, and behaviors must have roots from relevant research (Cooper, 2004) (Preece et al., 2002).

Saffer recommends limiting the number of personas to seven or less. An excessive amount of personas could provide an indication that the predefined target user group is not narrow enough, which can be destructive to the design process as the behaviors and goals may conflict. It might also negatively influence the design since a design created for many different goals may be mediocre at satisfying each individual goal (Saffer, 2007).

In summary, one of the advantages of using personas is that it helps remind the designers of the research conducted on the domain and the target users throughout the design process. In case the target user group is too wide, the process of creating personas may provide an early warning.

However, the use of personas in a design process has sometimes proven difficult as both designers and stakeholders may scrutinize the legitimacy of the personas by challenging the characteristics as unbelievable or irrelevant. The personas' characteristics include its behaviors, goals and motivations (Faily & Flechais, 2011) (Pruitt & Adlin, 2006).

While many other projects have adapted the creation and use of personas to fit both their team and purpose (Chang et al., 2008), Faily and Flechais suggests a more formal approach. While drawing inspiration from a methodology from social sciences called *Grounded Theory*, they have introduced the model: *Persona cases*. Persona cases define three steps in creating personas from relevant data: (Faily & Flechais, 2011).

1. *Summarize propositions*: Propositions are factoids, often in the form of quotations from user interviews, journals or observations.
2. *Argue characteristics*: Based on the propositions characteristics are created. Characteristics include activities, attitudes, aptitudes, motivations and skills.
3. *Write persona narratives*: The characteristics are then grouped by common behavioral variables, which supplemented by a narrative creates a persona.

This thesis finds it reasonable to be inspired by this more formal method of creating personas to ensure higher credibility, and will therefore attempt to employ these steps in their creation.

3.4 Idea generation

Idea generation is a key process when it comes to innovation (Shavinina, 2003). As such, it is an important step during a design process for communicating and developing ideas. There are several different idea generation techniques suitable to be used either in groups or individually. This thesis chose to conduct an idea generation technique called group brainstorming to facilitate the developing of concepts for the prototype.

This section breaks with the otherwise established convention within this chapter of only describing the method, and instead also intertwines some description of how it was used.

3.4.1 Group brainstorming

In order to generate ideas for the prototype, this thesis chose to conduct a group brainstorming session, an extension of brainstorming which is a well-known method for creative problem solving. Osborn first introduced variation of brainstorming in the book *"Applied Imagination"* in 1953 (Osborn, 1993). It involves gathering a team of participants for a common brainstorming session in attempt to generate more ideas than one would by brainstorming in solitude. Depending on the tasks chosen, group brainstorming sessions have the potential of both being both enjoyable for the participants, as well as improve the quantity of ideas generated.

This thesis gathered a total of four participants, which according to Lövgren & Stolterman can be considered sufficient. They claim that a group size between three to seven people is acceptable (Lövgren & Stolterman, 2004). In addition, Gallupe explains that large groups do not necessarily produce more ideas than smaller groups, as the average amount of ideas produced per participant actually decreases as the group size increases (Gallupe et al., 1992).

The researchers first wrote the problem or topic for brainstorming on a blackboard. Then each participant were handed several post-it notes and were explained the following two rules:

1. No one was allowed to criticize an idea.
2. The quantity of ideas was more important than their quality.

The above rules are according to Wilson the most important and basic rules for a successful group brainstorming session (Wilson, 2006). If participants experience criticism, it is likely that it may inhibit their creativity. Hence, the organizers informed the participants that the goal of the group brainstorming session was the quantity of ideas produced instead of their quality, as more creative ideas typically evolve based on the generated ones. A study performed by Paulus & Nijstad indicated a relation between the aggressiveness of a goal and the achieved result. This study found that participants that were given an aggressive goal twice the size of an expected achievement, increased their idea quantity with about 40 percent compared to those who did not receive such goals (Paulus & Nijstad, 2003).

3.4.2 Forced analogy

Forced analogy is a rather popular method where the participants are requested to forcefully compare a seemingly unrelated word or topic with the problem at hand (Proctor, 2010). The benefit of this method is that it often facilitates new perspectives and the creation of novel ideas. This is something that is often desirable as project designers might often get stuck in unilateral thoughts, hence inhibited from coming up with new ideas.

The group began by agreeing upon several random words that were not to be related to the thesis problem in any way. If “window“ were one of the chosen words, every participant would first write as many post-it notes as possible containing some word related to “window”, for example “mirror”. As mentioned, no connection between the words and the problem to be solved was necessary. On the contrary, less correlation between the word and the problem typically facilitates the production of even more and unexpected ideas, since the group´s restraints become less narrow. Together, the participants would then ask themselves “How could a mirror help facilitate answering the problem?” This question would hopefully contribute to producing some interesting ideas and concepts.

Due to all the participants being computer science students, this research project used personas to facilitate group diversity. Diversity amongst participants is often a beneficial factor for the creation of both idea diversity and quantity. However, it is important to keep in mind that this may also lead to the opposite, as group cohesion could be jeopardized since diversity could lead to awkwardness and discomfort amongst the participants (Milliken & Martins, 1996). These personas were based on the evaluation of the thesis’ journals and literature review. By using these personas, evaluation of the newly developed concepts became easier as the group were more able to discuss how appropriate the concepts would be in an actual user context.

3.5 Concept elicitation

Since the prototyping phase is typically very resource and time intensive, this project chose to use a formal method for selecting the most appropriate concept from the idea generation phase before continuing the project. By choosing a formal method of concept selection, it reduces the likelihood of this thesis having to iterate back to select a different concept, if substantial issues were to be discovered when testing the prototype. Additionally, since the prototyping phase is expensive, this project estimated that it would only be feasible to develop functional prototypes for one concept. Hence a prioritization phase was necessary to responsibly choose the concept this project were to continue developing.

3.5.1 Concept scoring

Concept scoring, developed by Ulrich and Eppinger, is a method that uses a set of criteria for prioritizing which concepts a project should invest resources in developing. This method was originally based on *Pugh's concept selection method* introduced in the 1980s (Ulrich & Eppinger, 2007). In contrast to Pugh's concept selection method, this relies on quantitative selection and ranking instead of subjective decisions from the team (Fager, 2004).

Furthermore, in contrast to Pugh's concept selection method, concept scoring is capable of handling differently weighted criteria, something that is common in the real world as one criterion may be more important than another. Instead of simply evaluating whether a concept is better, worse or equal than the reference concept, concept scoring increases the resolution and allows the evaluation to be more detailed (Ulrich & Eppinger, 2007).

For example, if the reference concept scores 3 for a criterion, a concept which was previously evaluated to be better (a "+" score in concept screening) can now be represented in more detail as it can be given any score above 3. Similarly for concepts evaluated to be worse than the reference can now be expressed as any score below 3. For a more detailed example, please see Figure 5: Example of a Concept scoring table .

CONCEPTS		A REFERENCE CONCEPT		B		C		D	
SELECTION CRITERIA	WEIGHT	RATING	WEIGHTED SCORE	RATING	WEIGHTED SCORE	RATING	WEIGHTED SCORE	RATING	WEIGHTED SCORE
EASE OF HANDLING	5	3	15	3	15	4	20	4	20
EASE OF USE	15	3	45	4	60	4	60	3	45
READABILITY	10	2	20	3	30	5	50	5	50
METERING ACCURACY	25	3	75	3	75	2	50	3	75
DURABILITY	15	2	30	5	75	4	60	3	45
EASE OF PRODUCTION	20	3	60	3	60	2	40	4	40
PRICE	10	3	30	3	30	3	30	3	30
TOTAL SCORE		275		345		310		305	
RANK		4		1		2		3	

Figure 5: Example of a Concept scoring table (Ulrich & Eppinger, 2007)

3.5.2 Divide the dollar

Since concept scoring does not define an explicit method for assigning weights to each criterion, this thesis decided to use a method called *Divide the dollar* to deduce the most appropriate weights. This was chosen to further formalize the elicitation of a concept.

In divide the dollar, the participants are given an equal stack of coins. These coins are then distributed amongst different set of items of their choosing as a representation of how much the participants value the different items (Bolt & Tulathimutte, 2010). As an example, one could add four coins to one criterion and two coins to another less important criterion. When all the coins have been distributed, the sum of the different criteria's is calculated. The researchers can encourage the participants to think aloud while pondering their decisions or the method can be performed in silence (Conrad, 2008).

3.6 Prototypes

Prototyping is an important part of a design process (Winograd, 1996). Prototypes are used to convey ideas and designs to the user, and they also work great as a communication tool amongst team members. Preece states that a prototype is "*a limited representation of a design that allow users to interact with it and explore its suitability*" (Preece, 2007). When exposed to users, they provide designers with information about the design. They are mainly divided into two categories, low fidelity and high fidelity, where the fidelity refers to its level of detail, complexity, and functionality.

3.6.1 Low-fidelity prototypes

Low-fidelity prototypes are usually used in an early stage of a design process. This method has become popular for brainstorming, designing, testing, and refining user interfaces (Snyder, 2003). There are several reasons why low-fidelity prototypes tend to be appropriate in many situations. One advantage they have, is that they allow you to demonstrate the design's behavior and appearance very early on. Since they usually consist of cheap material and they do not require a lot of development time, more iterations can be completed compared to developing a high-fidelity prototype (Rettig, 1994). In addition, designers are usually more willing to accept changes in such a low-fidelity design, which encourages the continued generation of new and alternative designs as well as increasing the quality of the final design. Low-fidelity prototypes are usually very simple paper based mockups, and are hence sometimes also referred to as *paper prototypes*.

Even though low-fidelity prototypes work great in many situations, they have limitations that made them insufficient for this project. Unlike high-fidelity prototypes, they are neither functional nor interactive. They tend to address layout, flow, and navigational issues. Being able to adequately simulate continuous and immediate feedback from the Kinect camera with the use of a low-fidelity prototype would be extremely difficult, hence the prototyping options for this project are quite limited.

3.6.2 Wizard of Oz

One alternative to typical low-fidelity prototyping would have been to use an approach called Wizard of Oz, which has evolved to become useful and relatively popular for advanced interfaces. In Wizard of Oz, the goal is to convince the user that he or she is interacting with a system, however this is not the case. In reality, the user is interacting with a human “wizard” sitting behind the scenes while simulating the user’s actions (Andersson et al., 2002). For this approach to be useful, the prototype must fulfill certain criteria. These are (Norman et al., 1991):

1. It must be possible to simulate the future system, given human limitations.
2. It must be possible to simulate the future system’s behavior.
3. It must be possible to make the simulation convincing.

In the context of this thesis, neither of these requirements would be easily achievable. Since the prototype would need to display continuous and immediate feedback through mirroring a user’s entire body, any keyboard/mouse simulation would most likely end up insufficient for the task. By only receiving minimal feedback on certain body movements, such as walking left or right, the researchers assume the user would experience the system as unconvincing. Therefore, this method was considered inappropriate for this thesis.

3.6.3 High-fidelity prototypes

Unlike low-fidelity prototypes, high fidelity prototypes are highly interactive and functional (Rudd et al., 1996). These prototypes are typically developed late in a design process and should represent how the final product will act and feel (Preece et al., 2007). Due to the fact that it is more functional than a low-fidelity prototype, a user testing the prototype will acquire a more accurate understanding of it, thus providing a better footing for thorough evaluation of the design (Preece et al., 2007).

For the purpose of this thesis as well as considering the weaknesses of the alternatives, developing a high-fidelity prototype seemed most reasonable. Additionally, some familiar libraries and tools already existed, and by using these tools, a working prototype could be developed within a short period of time. However when developing, there is always a risk of not overcoming certain difficulties, hence there was no guarantee of completing a functional prototype. Unresolvable bugs could have halted the development indefinitely which would have resulted in a delayed project. Additionally, performing a user-testing phase after putting such fair amount of work into the prototype would create difficulties in making changes or starting over if the tests indicated poor design (Preece et al., 2007). Despite these drawbacks, the project concluded that the positive sides of developing a high-fidelity prototype outweighed the negative ones due to the simple fact that a lower-fidelity prototype one would not be sufficient enough for this thesis purposes.

3.7 Testing and evaluation

The next step after developing a prototype is testing and evaluating it. There are four basic ways of evaluating a user interface; formal analysis, automatic using computerized procedures, empirically by user testing or observation, and finally analytically by evaluating the interface based on a pre-defined set of aspects and the evaluators' opinions. Models for formal analysis of interfaces are rarely used since they are somewhat immature as they are still being researched and developed (at the time of writing). Computerized procedures still require significant advancements in order to provide any useful data, and because empirical studies necessitate both large investments in time and resources, analytical evaluation (such as heuristic evaluation) has become increasingly popular as it relies on expert evaluators' opinions. Despite the expensive nature of empirical studies, such as user testing, it is still the most common method of evaluation and it does provide substantial amounts of relevant data (Jeffries et al., 1991) (Preece et al., 2007).

This section first introduces heuristic evaluation, a method that was used for evaluating the differences between the KUI and other interfaces, such as desktop and multi-touch. This method was chosen partly because it is simple to complete, but also because it is done by expert evaluators who can express the findings more coherently and explicitly than end-users. Further, this section then describes empirical user testing, which was used for testing the success and failures of the prototypes.

3.7.1 Heuristic evaluation

Heuristic evaluation is a method that requires few resources and little time as it relies on professional evaluators' opinions. It is therefore considered an informal method for evaluating the usability of an interface. Despite its informal nature and low resource requirements it has been shown to be very effective in uncovering serious issues (Preece et al., 2002) (Jeffries et al., 1991) (Nielsen & Molich, 1990).

Nielsen defines ten usability heuristics that this thesis has chosen to base the heuristic evaluation on (Nielsen, 2005). These heuristics are closely related to usability guidelines[6] and Norman's design principles[7], but also to motivational psychology[8].

The following usability heuristics were considered by this project:

1. *Visibility of system status* – "The system should provide immediate and appropriate feedback." This is closely related to one of the three conditions for Flow and is also essential to gaining a feeling of competence, which SDT explains is necessary for facilitating intrinsic motivation. In addition this heuristic is similar to two of Norman's design principles, feedback and visibility.
2. *Match between system and real world* – "The system should use concepts and language that the user is already familiar with." This is related to two of Norman's design principles, affordance and mapping. Furthermore, by lowering the learning curve one increases the initial gain in competence, which not only supports the creation of intrinsic motivation but in turn may also improve one's self-efficacy as the person experiences positive outcomes from the challenges.
3. *User control and freedom* – Norman's design principles also considers control to be an essential characteristic of a system. Additionally, some theories related to self-efficacy describe control to be an essential part in increasing self-efficacy.
4. *Consistency and standards* – "Users should not have to wonder whether different words, situations, or actions mean the same thing." Consistency is also Norman's fifth design principle to underline the importance of

[6] Please see section 2.3.1 for more about usability goals.
[7] Please see section 2.3.2 for more about design principles.
[8] Please see section 2.7 for more about motivational psychology.

following the established rules and norms for similar applications on similar platforms. This is to reduce the learning curve and allow the users to use actions they are already familiar with, subsequently making it easier to learn. This is also one of Preece *et al.*'s usability goals, "learnability".

5. *Error prevention* – An application should help prevent errors from occurring by, for example, eliminating error-prone conditions. This helps reduce frustration and helps reduce penalties in case of errors. By reducing penalties it could prevent a user's self-efficacy[9] from being negatively impacted, which in turn improves the chances of users with low self-efficacy to be more persistently involved.
6. *Recognition rather than recall* – The user should be required to memorize as little as possible in order to use the application. Actions and information should be recognizable. Similarly as a previous heuristic, this is closely related to Norman's design principle, affordance. By lowering the learning curve one increases the initial gain in competence, which not only supports the creation of intrinsic motivation but in turn may also improve one's self-efficacy as the person experiences positive outcomes from the challenges.

While heuristic evaluation has historically focused on uncovering usability issues, this project has found it appropriate to add a seventh non-standard heuristic that focuses on the general perceived user experience.

7. *User experience* – Throughout the history of interaction design, UX has been problematic to define, despite most designers having a common but vague understanding of the term. One description is that "[…] *UX is a consequence of the user's internal state* […]" when interacting with an

[9] Please see section 2.8 for more about self-efficacy.

application. In contrast to being task-focused, UX revolves around the user's emotions.[10] The evaluators will attempt to describe and compare their experience when evaluating the different interfaces.

Among the most common heuristics, these were not included:

- *Flexibility and efficiency of use*
- *Aesthetic and minimalistic design*
- *Help users recognize, diagnose, and recover from errors*
- *Help and documentation*

The reason they were not included was because they were evaluated as less relevant to the topic of interest in this part of the study.

3.7.2 User testing

User testing is commonly considered an unfortunate metonym for *usability testing* (Cooper et al., 2007). While most user tests focus almost solely on evaluating the instrumental value of a prototype application, this thesis is slightly more interested in the user experience aspect. Therefore, this thesis has consciously chosen to use the term *user testing* as it hopes to test both the usability as well as the user experience of the prototypes.

In usability testing, test subjects are often given tasks. The test subjects' performance is measured while they attempt to complete the task and quantitative data is subsequently generated. This data provides an indication on how successful the prototype was at allowing the test subjects to complete the given task (Preece et al., 2007). However, considering that the definition of

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[10] For more about user experience, please refer to the chapter:

Theory › Interaction Design › User Experience

user experience is still being refined (Hassenzahl & Tractinsky, 2006), it is evident that measuring it is more complex.

Even though the research community is still processing the definition of user experience, it is commonly agreed that a user's experience of an application is comprised of his or her emotions perceived during the testing (Preece et al., 2007). While there are several ways of measuring emotion, two common ways are to measure either through self-reporting by the test subject[11] (Desmet, 2003) (Capota et al., 2007) or observation of behaviors and facial expressions during testing. However, those types of methods have been tested and evaluated as insufficient for the field of interaction design (Burmester et al., 2010), hence Burmester, *et al* introduced the *valance method* in 2010 (Burmester et al., 2010).

3.7.2.1 Valance method

The valance method is conduced by first allowing the test subjects to freely explore the application while being video recorded. They are instructed to record negative and positive emotions with a simple button press whenever they experience them. This is the "exploration phase". Later, the researchers interview test subjects about their experiences and emotions during the exploration phase. This interview is done with the help of the video recording as well as the button press-logs. The purpose of this interview is to investigate which aspects caused the button press, and what the related needs were. This is the "retrospective interview phase". The interview transcripts are then analyzed (Burmester et al., 2010).

[11] Examples of self-reporting methods include the Product Emotion Measurement Instrument (PrEmo) and Layerd Emotion Measurement Tool (LEMtool).

This project has chosen a user testing method inspired by the valance method. However, instead of having the test subjects record their emotions in the exploration phase to then discuss them in the proceeding retrospective interview phase, this thesis will instead interview the test subjects simultaneously as they explore the prototype, partly to conserve time and resources. Another part of the reason why we chose to combine the two was because it would be difficult to let users click buttons when testing a KUI interface requires lots of free space and major body movements. Nonetheless, this method will still video record the testing and will also avoid giving the test subjects tasks (which is common in traditional usability testing). Burmester, *et al.* argues that the by giving test subjects concrete tasks, they become focused on completing an extrinsic goal instead of following their own needs and developing their own intrinsic goals, which affects the perceived emotions (Burmester et al., 2010). Furthermore, this thesis will also conduct the interview with the same purpose as described in the valance method.

3.7.2.2 Formative evaluation and interviews

However, since this is a fairly new method, this project has found it prudent to prepare an alternative-testing plan. If the valance method proves difficult to conduct, then this thesis will fall back to performing follow-up interviews after each testing session. The interview was planned to be semi-structured as such interviews offer more consistency in the data gathered, while simultaneously being able to ask interviewees about interesting and relevant tangents (Preece et al., 2007). Please see the appendices for the interview guide.

Additionally to testing the prototypes formally with a final summative user test, this project has continuously invited potential users to informally test the prototypes while in development. This method is a form of *formative evaluation*, which simply means that the prototypes are continuously evaluated during development. Formative evaluation is typical for an iterative development process, which this project attempts to adhere to. Although such user tests during the development process are typically short and very informal, they are still useful as they continuously allow the designers to see if they are on the right track (Preece et al., 2007) (Cooper et al., 2007). Since the prototype phase was expensive, this thesis chose to implement this form of formative evaluation by potential users to incrementally reduce issues before a final summative evaluation.

4 Case

The purpose of this chapter is to introduce the case study and how this thesis processed each sub-research question using the various research methods. It includes a thorough explanation on how each research method was conducted. This section does not introduce the methods chronologically, but instead they are grouped by which sub-research question they were employed to investigate. Additionally, this chapter will introduce both the hardware and software that was used, present the target user group, and the setting of use.

4.1 Establishing the target user group and the setting

This project chose the primary target user group to be youth of normal health. The age-restriction was partly due to the proven health benefits of physical activity in early life and partly because youth are the ones most likely to be familiar with similar technologies and also tend to play video games more frequently. Furthermore, by eliminating users who can be categorized as clinically obese or otherwise unhealthy, this thesis reduces the likelihood of data being influenced by external medical aspects. The target user group has been involved during several research stages of the thesis, including self-reporting through journals, contributing in the idea generation phase, and user testing of the prototype.

Considering that many youth spend a significant amount of time playing video games, this thesis had the ambition to explore the consequential relationship between the target user group and the chosen technology with respect to exercise. The setting for this relationship is the user's home when he or she is playing a video game. This thesis therefore found it reasonable to attempt to introduce a peripheral component aimed at providing feedback about the user's physical activity while he or she is already interacting with a KUI game.

4.2 Microsoft Kinect

Microsoft Kinect[12] is a motion-sensing camera developed by Microsoft originally for the Xbox 360 video game console, but the company has announced it will also be available for Windows 8. This input device enables users to interact with the video console without the need of physical touch via full body 3D motion capture and voice recognition. Microsoft's intention with the Kinect was to attract a younger audience as well as allowing themselves to compete with Nintendo´s Wii and Sony´s PlayStation Move. The device was released in November 2010; either to be bought bundled with the Xbox 360 console or as a peripheral device for those already owning an Xbox 360. Kinect currently holds the Guinness world record for fastest selling gaming-peripheral device[13].

The camera is motorized and is able to tilt itself vertically dependent on the users position. Normally, it would be placed either on top or beneath the television facing the user. The device has a 43° vertical by 57° horizontal field of view. It provides a frame rate of 30 frames per second and a resolution of 640 x 480 pixels. The device features a RGB camera, depth camera and a microphone array. The RGB camera can detect three color-components, namely red, green, and blue, which can be used to detect objects and recognize faces. Its depth camera has a range of 500 – 4000 millimeters. It consists of an infrared projector and a monochrome CMOS (complimentary

[12] http://www.xbox.com/en-US/kinect

[13] http://www.guinnessworldrecords.com/world-records/9000/fastest-selling-gaming-peripheral

metal-oxide semiconductor) that together allows the camera to collect three-dimensional data, which developers can use to extract different objects from the scene. The microphone array is an array of four microphones and each channel processes 16-bit audio with a sampling rate of 16 kHz. The microphone array supports echo cancelation and noise suppression, which facilitates the use of voice recognition, as the users commands becomes more distinguishable from the surroundings.

Figure 6: Microsoft Kinect camera and its components

Although the main purpose of the device was to interact with Xbox 360 games, its potential use in other scenarios quickly became apparent after its release. Soon after its release, hobby developers as well as academics managed to produce third-party software drivers that allowed the device to interact with standard desktop computers. This opened up new opportunities for the technology and encouraged Microsoft to release their own Kinect SDK for developers. Some examples of available open source libraries available at the time of writing are SimpleOpenNI[14], OpenKinect/libfreenect[15], and OSCeleton[16]. The release of these libraries has given birth to numerous

[14] http://code.google.com/p/simple-openni/

[15] http://openkinect.org/wiki/Main_Page

[16] https://github.com/Sensebloom/OSCeleton

innovative KUI applications contributing to the fields of robotics, arts, physical health, etc.[17]

This thesis chose to explore the Kinect due to its more novel technology compared to similar devices such as the Nintendo Wii and Sony's PlayStation Move. Furthermore, Kinect's ability to sense the entire body versus tracking only one 3D point from a peripheral hand-device made it more appropriate for this thesis, since a larger amount of information could be deduced about the user´s physical activity.

4.3 Processing

Processing[18] is an open source programming language as well as an integrated development environment targeted for the electronic arts communities. Its purpose is to aid computer programming within a visual context allowing developers to draw graphics, create animations, and interactions. It is built on the Java programming language and they share a similar syntax. It can also be used as a separate Java library. This thesis utilized Processing as a tool to draw the graphical interface, which included visualizing the user as well as to provide him or her with immediate feedback about his or her exercise progression.

4.4 Open source libraries

OpenNI[19] (Open Natural Interaction) is a cross platform framework that provides an application-programming interface (API) for developing applications that utilizes natural interaction when communicating with audio

[17] For examples of other uses, please see http://www.kinecthacks.net/

[18] http://processing.org

[19] https://github.com/OpenNI/OpenNI

and vision sensors. This API allows developers to write code independent of the sensor device at hand.

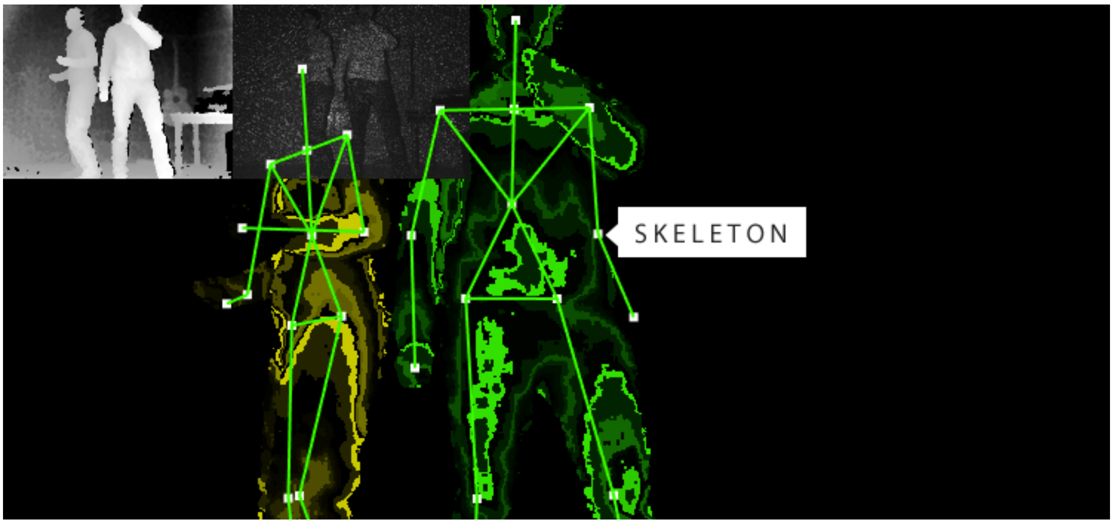

Figure 7: Skeleton tracking with OpenNI and NITE (from PrimSense´s sample projects).

NITE[20] consists of computer vision algorithms that translate movement into application input without the need for any additional input sources. It facilitates skeleton tracking, gesture-detection, a scene analyzer, and hand-point analyzing that can be applied to applications.

As this thesis wished to use OpenNI, NITE, and Processing in developing the prototype, a suitable library called SimpleOpenNI[21] was used. SimpleOpenNI is a library for Processing that works as a wrapper for OpenNI and NITE. This library provides all the same functionality as OpenNI, as it enables developers to capture the user's skeleton (i.e. the position of each skeleton joint), RGB video feed, infrared video feed, and depth camera video feed from the Kinect camera. At the time of developing, it did unfortunately not have support for communicating with Kinect's microphone array.

[20] http://www.primesense.com/nite

[21] http://code.google.com/p/simple-openni/

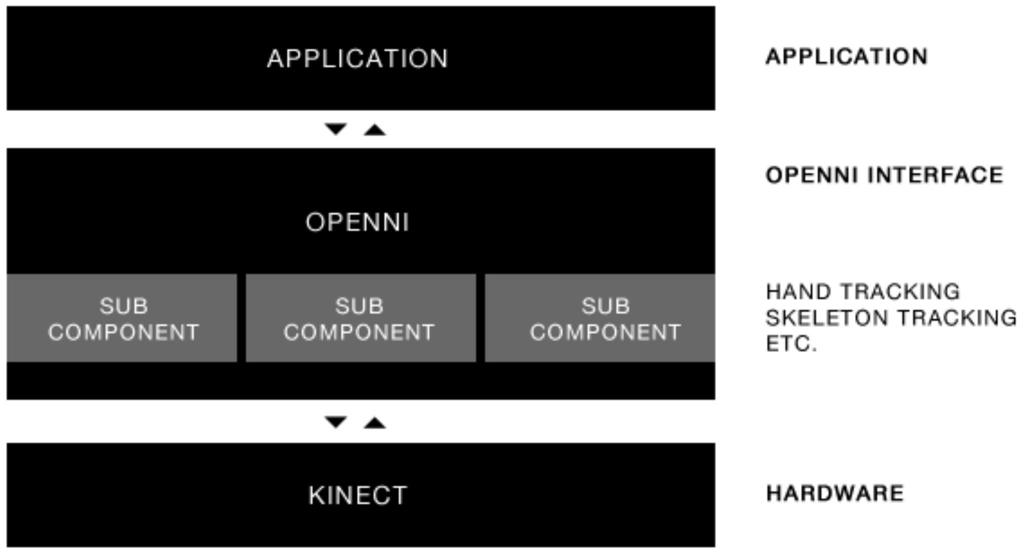

Figure 8: The architecture of OpenNI

Flexible Action And Articulated Skeleton Toolkit (FAAST)

FAAST[22] is a middleware that facilitates full body control of computer applications. FAAST builds on OpenNI and uses a Virtual-Reality Peripheral Network (VRPN) server to stream the users´ skeleton information over a network, thus enabling computer applications to read this skeleton information using a VRPN client. Furthermore, FAAST includes predefined body postures and gestures such as “swipe left” and “lean right” that can be custom mapped to different keys on the keyboard, which consequently triggers events in the application. With this mapping, existing applications and games designed for desktop computers that do not support a KUI can be controlled via one.

When conducting the heuristic evaluation, this thesis utilized FAAST to control the game Morrowind. This game was originally developed for the

[22] http://projects.ict.usc.edu/mxr/faast/

desktop interface, but FAAST allowed the researchers to control it with the use of the Kinect. The setup is shown in Figure 9.

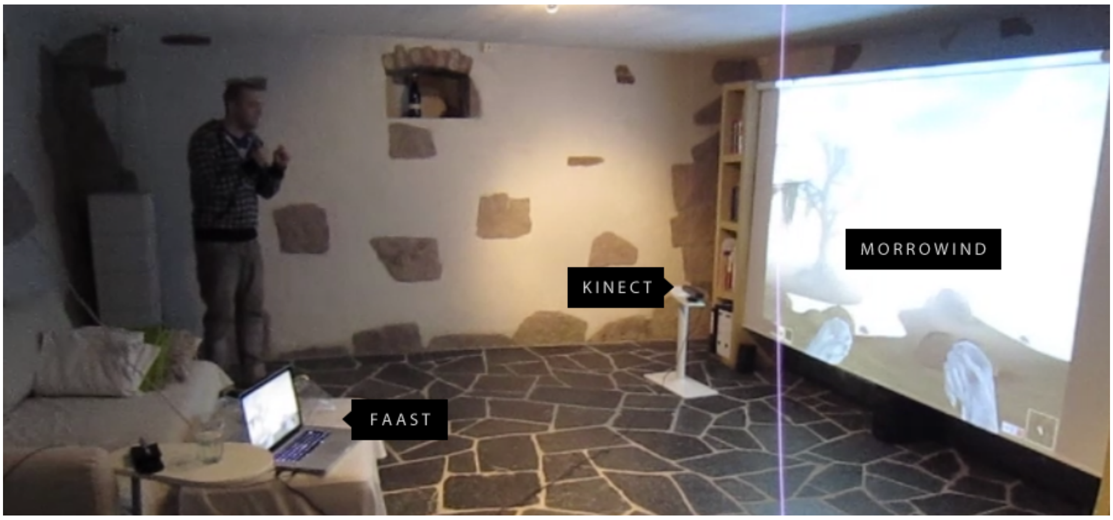

Figure 9: A user interacting with Morrowind using Kinect and FAAST.

The following sections explain how the methods were used. Instead of being grouped by phase, they are organized under which research question they were primarily employed to study.

4.5 RQ 1: Which aspects are essential for a KUI application to provide a good UX and usability compared with applications with other interfaces?

To investigate the first research question, this thesis conducted a heuristic evaluation of the game Fruit Ninja on both KUI and multi-touch interfaces. Additionally this thesis evaluated the game Morrowind on a desktop interface as well as with a KUI interface. The purpose was to explore the KUI´s advantageous aspects by comparing it to the other interfaces. In addition, this thesis also performed a heuristic evaluation on one existing KUI application.

This method was carried out by a total of three evaluators who all have experience with both the methodology as well as the technology. During the evaluations one evaluator was designated as the note-taker to ensure that all findings were recorded.

Figure 10: During Heuristic evaluation of Morrowind using the Kinect and FAAST.[23]

The results from these studies were to provide an indication of which aspects the KUI was comparatively more sufficient in satisfying, as well as the aspects required to facilitate a better user experience for a KUI application. To facilitate integration of full body control on the desktop interface, the study employed FAAST. This software made it easy to interact with the game Morrowind using the Kinect camera.

4.6 RQ 2: Which conditions are most prominent in facilitating motivation for exercise?

In addition to reviewing literature about motivational psychology, this thesis employed the journals method of self-reporting to gather original data

[23] For video, please visit: https://vimeo.com/29038431

relevant to this research question. These journals were created with inspiration from cultural probes (as mentioned in the previous chapter).

The journals encouraged the participants to record their emotions and motivations both before and after each exercise session as well as completing a very small set of tasks each day. This was included to uncover how the participants motivated themselves to exercise normally. For more details about the tasks please see the appendices.

Figure 11: Photos of a participant's journal

A total of five participants were given one journal each to write in every day for seven days. The ages and genders of the participants were: girl (17-19), girl

(20-22), boy (22-24), boy (13-15) and boy (13-15)[24]. Please see Figure 11: Photos of a participant's journal.

Based on the analysis of the data from the journals combined with relevant literature four personas were developed (see Figure 12). For the full profile of each persona, please see the appendices.

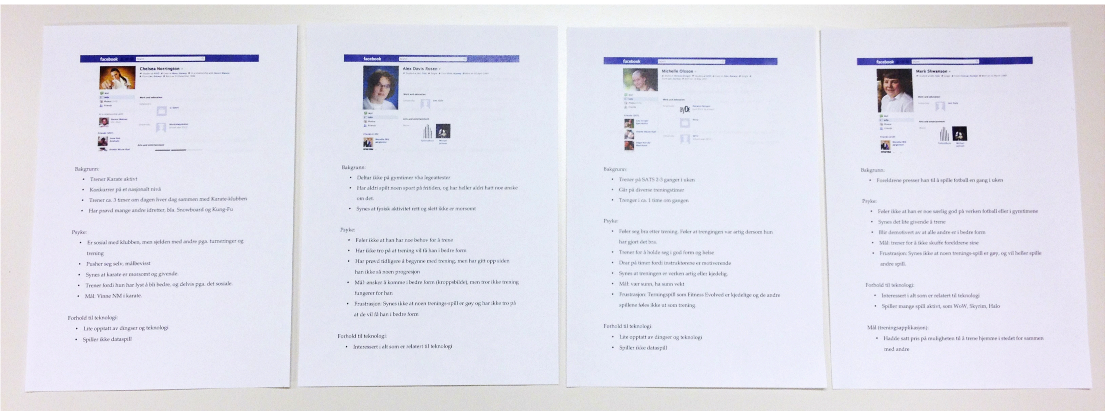

Figure 12: Photo of the four personas based on the analysis of the data from the journals combined with relevant literature.

4.7 RQ 3: Which challenges are relevant when exploring the relationship between exercise motivation and feedback from a peripheral KUI application?

To explore this research question this thesis found it appropriate to develop a prototype to incorporate the previously found advantageous aspects of KUI to attempt to facilitate exercise motivation. During this process and testing of that prototype this thesis would collect and analyze outstanding challenges that might affect the relationship.

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[24] The ages have been intentionally obfuscated to help reduce the likelihood of the participants being identified, which was required by the Norwegian Social Science Data Services. Please see appendices for receipt.

The first step in creating a prototype was to generate ideas for a concept. This was done in the idea generation phase using group brainstorming. The ideas that were generated were grouped into simple concepts, which were evaluated against each other in the following concept elicitation phase. A prototype was then developed based on the chosen concept, and finally user tested, not so much to evaluate whether or not the advantageous aspects of KUI actually facilitated exercise motivation, but primarily to discover any aspects or challenges that might influence such a study.

4.7.1 Idea generation

This thesis conducted a brainstorming session to help generate ideas for the prototype. A total of four participants, including the researchers themselves, were gathered in a meeting room for a two-hour session. A method named forced analogy was chosen for its inherent ability to produce many and diversified ideas.

To facilitate and force additional group diversity, this study made use of the personas that were created from analysis of the journals and relevant literature. The primary task given was: “How can the advantageous aspects of KUI be used in a peripheral application to help facilitate exercise motivation?” The participants were also briefly introduced to the preliminary findings from the two previous sub-research questions.

Figure 13: Photo of two of the group brainstorming participants.

4.7.2 Concept elicitation

This thesis conducted an elicitation method called *divide the dollar* to help select the most important criteria for eliciting a concept. The participants were the two project researchers. 118 coins were divided amongst the participants, and they had to distribute these between the following criteria of their choosing:

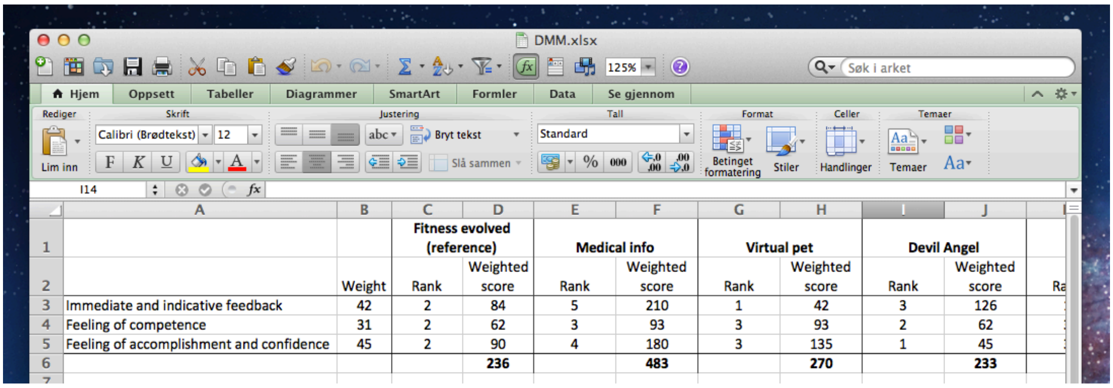
- Immediate and indicative feedback
- Feeling of competence
- Feeling of accomplishment and confidence
- Feeling of autonomy
- Guiding agent
- Social aspect

These criteria were extracted primarily from the journals, but with influence from relevant literature.

The method was completed not based on the participants' subjective opinions, but instead the personas' simulated opinions. As the participants had to simulate the personas' values, interests, and goals, the process had to be repeated several times. When all the coins had been distributed, the sum of the different criteria's was calculated, and the ones with the highest were considered most important.

Figure 14: Photo from divide the dollar-method being conducted.

After the criteria were assigned weights, the various concepts developed during the group brainstorming sessions were evaluated using concept scoring. This method provided a clear indication of which concept was most logical to continue with.



	Weight	Fitness evolved (reference) Rank	Fitness evolved (reference) Weighted score	Medical info Rank	Medical info Weighted score	Virtual pet Rank	Virtual pet Weighted score	Devil Angel Rank	Devil Angel Weighted score
Immediate and indicative feedback	42	2	84	5	210	1	42	3	126
Feeling of competence	31	2	62	3	93	3	93	2	62
Feeling of accomplishment and confidence	45	2	90	4	180	3	135	1	45
			236		483		270		233

Figure 15: This thesis' concept scoring results.

4.7.3 Prototyping

As explained more thoroughly in the methods chapter, this project chose to develop a high-fidelity prototype to investigate this research question. The prototype was developed to be a peripheral application to an existing KUI game. It would provide medical information to the user while he or she is playing a game. Its purpose was to inform the user that he or she is exercising, and hopefully motivate the user to continue playing.

The prototype was developed in the Java programming language with some 3rd party libraries, amongst them were SimpleOpenNI developed by the Interaction Design Department Zurich. This library is an OpenNI and NITE wrapper that enables developers to capture the user's skeleton (i.e. the position of each joint), RGB video feed, infrared video feed, and depth camera video feed from the Microsoft Kinect camera. Additionally, the prototype used Processing's Java libraries for drawing graphics.

Figure 16: Screenshot of the prototype. For video, please visit: http://vimeo.com/40804586

The prototype estimates the energy expenditure of each limb based on the average weight of that limb using a simple formula for calculating kinetic energy given mass and speed. The speed of the limbs is calculated from the limbs' movements relative to the user's body, and the mass of each limb is estimated based on the average person's weight and the average weight distribution between limbs[25].

As soon as the Kinect camera recognized the user, the application measured the user´s biometrics and presented it to him or her via audio feedback. These biometrics´ were mainly the lengths of the user's limbs. The prototype immediately starts to capture the user´s movements in order to calculate the energy expenditure of each body part. The audio feedback was given continuously until the user reached 100% of the daily exercise goal. Examples of audio feedback given were "*Increasing oxygen consumption. Increasing lung capacity.*" and "*Completed 10% of todays exercise goal*". In addition to audio, the user was given immediate and continuous visual feedback on his or her energy expenditure as well. The informative medical messages were formulated with the help of medical researchers.

The prototype was developed over the course of two intense weeks and several revisions were made based on informal formative user testing. More information about the prototype, the technologies used, videos of it being tested, and how to download and install it, can be found in the appendices.

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[25] For more data about this distribution, please see "Human Body Dynamics: Classical Mechanics and Human Movement" page 302. Table: Segment Properties

4.7.4 User testing

The prototype was tested by a total of nine test subjects. The test subjects were first instructed to play FruitNinja on Xbox 360 with the Kinect, and then introduced to the prototype while playing the same game. They were interviewed in the same manner as the valance method while they were playing. Additionally, the researchers had prepared some extra interview questions to promote discussion for the more reserved test subjects. Notes were taken continuously in addition to video recording. During the user testing the researchers decided to switch to the prepared interview script.

Figure 17: Photo of the equipment setup during the user testing session.

Due to technical limitations, the prototype was on a separate screen next to the screen that the game was on, as shown on Figure 17: Photo of the equipment setup during the user testing session. The participants had to stand approximately 3-4 meters away from the display in order for the Kinect camera to record their entire body. The main display was approximately 42 inches large while the prototype display was only 24 inches. The interview script can be found in the appendices.

5 Results

This chapter presents the results procured during this project. The results are grouped by research question they belong to.

5.1 RQ 1: Which aspects are essential for a KUI application to provide a good UX and usability compared with applications with other interfaces?

In order to understand the how a KUI may be different from existing interfaces such as desktop and multi-touch this thesis has evaluated two different existing games, one on both desktop and KUI and the other one on multi-touch and KUI. Additionally, the thesis has also evaluated an existing game designed specifically for the KUI.

5.1.1 Evaluating games across interfaces

This heuristic evaluation was less focused on the gameplay and content and more focused on the differences in the interaction. This was because the purpose for these heuristic evaluations was to contrast KUI against other interfaces to attempt to deduce its advantageous aspects.

5.1.1.1 Desktop versus KUI

The first game this thesis chose to evaluate with different interfaces was the free-world 3D game Morrowind. The game was first tested with the intended interface (desktop mouse and keyboard) and then connected with a Kinect camera and gesture recognition software in an attempt to discover how the different interfaces impacted the experience of the gameplay. Although the Kinect controlled version of Morrowind was functional the Kinect with the gesture recognition software could not deliver the accuracy and controls this game required, hence it made the experience more frustrating than rewarding. Despite the substantial differences in controls and accuracy, this thesis performed a brief heuristic evaluation of Morrowind with these two interfaces, as it was interesting to examine a case where a KUI proved inappropriate.

1) *Visibility of system status*

- The evaluators were not aware of which commands had been recognized as the application with the KUI did not provide the necessary feedback. Additionally, due to the lack of accuracy the user sometimes activated commands unintentionally. There was very little correspondence between what the evaluator tried to communicate and what the application displayed. On the desktop version it was easier to know which commands had been recognized as the tactile feedback of clicking a button or pushing a key on the keyboard gave the evaluator adequate feedback.
- Morrowind had two viewpoints, first person view and third person view. The evaluators discovered that the application was much easier to use with the first person view with the KUI, especially if the evaluator held their hands in the same position as the character on screen. This created a feeling of correspondence between the evaluator's actions and the representations on the screen. On the desktop version the evaluators discovered there was little difference in the different viewpoints as there was in any case no correspondence between the evaluator's body positions and the character on screen.

2) *Match between system and real world*

- There was some correlation between the user's actions and the effects in the application with the KUI. When the user walked in-place their character walked, and when the user punched with their hands the character punched with their hands. However, since the screen and camera was only directly in front of the user, the user had to turn their upper-body slightly to the side in order to turn the character around, which does not correspond with the real world. Nevertheless, the evaluators found it significantly more correspondent with the real world than the desktop interface, as the user did not click buttons or push keys to move his or her body.

3) *User control and freedom*

- When testing the game with the traditional desktop interface the evaluators discovered that the game created a feeling of autonomy, as the game environment was massive and virtually unrestrictive. However, when testing the Kinect version, the lack of accuracy and control negatively impacted the feeling of autonomy, as the evaluators did not feel in control of their actions. In other words, the difficulty of communicating commands to the application via the KUI destroyed the feeling of autonomy that was created with the desktop interface.

4) *Consistency and standards*

- The desktop version relied on the user communicating via keyboard and mouse. The various keys and mouse actions were based on what was commonly used for similar desktop games. Hence the evaluators found that the desktop interface was relatively consistent to what they would expect from such an application.
- The KUI version, however, required the user to move their entire body to communicate with the application. Since this form of interface is relatively new it was difficult to consider how consistent it was since there are (at the time of testing) almost no standards. On the other hand, since the user communicates using his/her entire body through

this interface, it recognizes real-world gestures and actions, such as punching, walking, jumping, etc. While the evaluators agree that the KUI version had almost no standards to follow, it was more consistent to how someone would interact in the real world, sans interface.

5) *Error prevention*

- Due to the inaccuracy of the Kinect camera and the gesture recognition software the user's gestures were often misinterpreted, hence he or she often made mistakes. In contrast, the mouse and keyboard of a desktop interface were very accurate.
- Since the application portrayed an unrestrictive 3D world from a first-person perspective, and since the user controlled the character with their body by performing real-world actions, the user gradually began to expect the same freedom in the application as in the real world. However, since the application did not indicate any restraints the user did not intuitively understand which actions would be recognized before performing them, which caused more user errors.

6) *Recognition rather than recall*

- In the desktop interface all the actions were bound to separate keys on the keyboard, which meant that the user was forced to remember the mapping between the keys and the actions. On the KUI version, basic actions, such as walking and hitting, were the same as what the user would have done in the real world, which made those actions more affordable.

7) *User experience*

- The evaluators concluded that while the novelty of the new interaction method the KUI offered proved engaging at first, this novelty quickly wore off as error frequency and lack of accuracy became increasingly frustrating.

5.1.1.2 Multi-Touch versus KUI

This thesis chose to evaluate the game FruitNinja, as it had been developed for both a KUI and a multi-touch interface. Since the purpose of this evaluation was to discover how a KUI might provide a different experience than a multi-touch interface, this evaluation was focused on the difference between the two interfaces instead of the interaction of each interface.

Figure 18: FruitNinja on Kinect. Photo by Martin Toft.

1) *Visibility of system status*

KUI version:

- The KUI version had a shadow behind the scene showing the user's position. It indicated that the application was acutely aware of the user's presence and actions. It was also immediate as well as accurate which gave the user a reaffirmation that their actions were communicated and understood by the interface. In addition, the shadow also helped the user to understand "where he or she was in the game" which lowered the difficulties of using the application. It also gave the user constant and immediate feedback reassuring him that the application was constantly and without delay ready to accept commands from the user, which increased the feeling of control and trust.

- One of the evaluators got the impression that the system was aware of his presence due to the virtual shadow, and although he easily communicated his commands he was unsure how the system managed to interpret his actions as commands.
- An evaluator also stated that the contrast between the shadow in the background and the objects in the foreground was too low, which made it difficult to see both at once. Since the shadow was crucial in communicating that the system was aware of his presence, he explained that it would perhaps be beneficial if it were more visible.
- When a user was "slicing" the application clearly showed a highlighted path where the "slice" occurred, which gave the user feedback that his command had been recognized. However, the "slice"-recognition was sometimes inconsistent or difficult to predict and users occasionally inadvertently performed that command without intending it.
- When a user struck an in-game object, the application showed an animation of the object being hit, which provided adequate feedback to the user that the user's action was successful. If the user missed the object, the user only saw their "slice"-path next to the object, which again gave clear feedback that it was a miss.

Multi-touch version:

- Since this device could not detect that the user was present when not touching the screen, the evaluators experienced more control and trust when using the KUI-version. The evaluators felt less “present in” the application with this interface than the version with the KUI.
- The application showed that user was communicating a “slice”-command as soon as the user touched the device. The visual and tactile feedback provided was both immediate and very accurate.
- Since there was a direct correlation between the input sensor (touch sensor) and output signal (screen), the evaluators quickly became confident that the application understood the commands given with high accuracy.

2) *Match between system and real world*

- Since evaluators saw their virtual shadow in the KUI version they believed it would be more obvious for a first-time user to deduce what was required of him or her to interact with the system compared with a multi-touch interface. One evaluator explained that people are most likely familiar with seeing shadows of them in the real world, and would subsequently understand that the system was aware of their presence.
- Since the user performed an actual slice-gesture with his or her arm to communicate the “slice”-command to the application with the KUI, it was very much in correlation with how slicing is done in the real world.
- One of the evaluators stated that since the KUI required the user to move their entire body (as they most likely would need to in the real world), instead of simply tapping or swiping on a flat multi-touch display, it would be easier for a novice user to understand how to

interact with a KUI, given that the novice user is already familiar with this form of interface, but not the application.

- The in-game objects were often “launched” from the bottom of the screen in a curved path, and then fell down. Because the screen for the KUI version was usually mounted vertically in front of the user, it made sense that the objects travelled in these paths as a real world object subject to gravity would travel the same approximate path. When playing the game on a multi-touch interface it was most comfortable and convenient to lay the device on a horizontal surface, which meant that there was little correlation between the movement paths of the in-game objects and real world objects.

3) *User control and freedom*

- As mentioned previously under heuristic 1, the KUI for this application was slightly less accurate than the multi-touch interface, which gave the user a reduced impression of control. Furthermore, external factors such as disrupting light sources influence the sensors, which further reduced the accuracy.
- When the user interacted with the application through a KUI, i.e. using his or her entire body, the evaluators noticed a stronger sense of freedom. The evaluators did not have any physical constraints to the size of a touch-screen or to certain gestures. The only, so to speak, restriction was the evaluator’s own body.
- One evaluator found that the multi-touch interface was much more accurate than the KUI and he felt more in control of his actions on the multi-touch interface. The KUI interface seemed more error prone.
- One evaluator mentioned that the multi-touch interface only accepted very simple interactions (tap, swipe, pinch, etc.) while the KUI could

interpret more complex interactions. He experienced therefore more freedom with the KUI.

- Since a user interacted with the KUI-version simply and only by moving his or her body, the user experienced a lack of authenticity. This was because the user was subconsciously familiar with interacting with real world objects by touching them. Since the Kinect could not provide this tactile feedback to the user, the evaluator felt a slight disconnection between his actions and the result.

4) *Consistency and standards*

- For the multi-touch interface, the evaluators found that they expected that simple tapping to be sufficient in communicating with the application. This was because similar mini-games mostly relied on simple tapping gestures instead of "slice"-gestures. Hence, the evaluators found that the application with the multi-touch interface was rather inconsistent to its peers.
- Similarly as with the previous comparison between the desktop interface and KUI, there were little to no standards for the KUI at the time of testing.

5) *Error prevention*

- Since the evaluators were given continuous feedback of their presence through the "shadows" in the KUI version, it was easier for them to know if they inadvertently stepped outside the KUI camera's view.
- One evaluator was under the impression that the KUI was less precise which caused him to make more errors. Since the multi-touch interface was more precise, there were fewer user errors caused by the interface.
- Another evaluator noticed that since the KUI provided no tactile feedback when he communicated a command it was easier to

understand that a command had been communicated on the multi-touch version, which contributed to less user errors since he, for example, did not have to repeat commands that were not communicated.

- The evaluators also noticed a slight delay with the KUI. There was a slight delay from the moment they acted till the moment the system finished interpreting the command, which contributed to reducing the precision, hence increased the amount of user errors.
- Since the KUI version did not notify the user when he or she was too close or too far away from the sensors, the evaluators experienced and believed other users would make more mistakes because of this.
- Furthermore, since the evaluators gradually became confident that the application was aware of them (because of the constant visual feedback – the shadow), the user therefore dedicated more trust to the application, and because of that trust, the evaluators expected the application to be more aware of their intentions. However, although this application, for example, noticed that the evaluators stepped outside the KUI camera's view, it did not assist them by pausing the application. On the other hand, since the multi-touch version did not give any indication of it being aware of the user when they were not touching it, the evaluators did not dedicate this level of trust to it, hence they did not expect that awareness.

6) *Recognition rather than recall*

- The evaluators additionally found the KUI to have more restrictions than the multi-touch interface (which may at first seem contradictory to a previous statement). One evaluator explained that since the KUI appeared as only a camera in front of the user, the user has no other choice other than to move his or her body. The multi-touch interface on the other hand could accept several types of gestures that the user was most likely already familiar with, for example tap, swipe, pinch, etc. This restrictive nature of the KUI contributed to better affordance.

- One evaluator also believed that a novice user, such as his mother, would grasp the KUI version quicker and more easily than the multi-touch version.

7) *User experience*

- The evaluators found a session with the KUI version more rewarding than with the multi-touch version. This was partly because the KUI version required more activity of the user, which to the user felt more of an accomplishment than simply sliding fingers across a screen.
- Although the evaluators stated that the multi-touch version was more precise and offered more control, they also said they would gladly trade that control for the increased engagement they experienced when using the KUI version. This was because they felt it was less challenging and less rewarding to communicate commands to the multi-touch interface than to the KUI. They meant that swiping and tapping on the multi-touch interface was something more people were already familiar with in contrast to full body movements. They believed it would be less rewarding for people to do something that they already are familiar with.
- Additionally, the evaluators found the KUI version to be more engaging and fun to use than the multi-touch version. One evaluator said that he only used the multi-touch version when he was extremely bored but could envision himself using the KUI version more often.
- One evaluator also theorized passionately that some of the reasons he found the KUI more engaging to use were due to theories around embodied cognition/interaction. He explained that since the interface

required him to move his entire body, that movement positively influenced his cognition and mood of the interaction between him and the system.

- Another evaluator also mentioned that he believed the KUI would be more likely to create social settings because it required users to move their entire body instead of simply sitting around a screen. He believed this was partly due to the positive effects of moving the entire body instead of only moving one's fingers.

5.1.1.3 Existing Kinect game

In addition to examining the differences in experience between various types of interfaces compared to a KUI, it is also of interest to examine existing KUI applications. From such evaluations one might discover preferable and non-preferable properties.

1) *Visibility of system status*

- Fighters Uncaged did not show a direct visualization of the user within the game but only an avatar, which made it difficult for the user to know whether or not the application understood the commands that were given.
- Since the controls for Fighters Uncaged was gesture-based it meant that the application had to wait until the user finished a gesture before visualizing it. This meant that the feedback was not immediate and hence the user was often unaware whether or not his or her actions were adequate to complete the challenges.
- The game displayed visual clues of the acceptable commands/gestures and what effects they corresponded to. This was present most during

the introduction/guidance phase. The visual clues were mostly pictographs depicting gestures.

2) *Match between system and real world*

- Fighters Uncaged attempted to translate the user's actions to the main character, which meant that when the user punched or kicked, the application displayed animations of the main character doing so. However, since the application was gesture-based, the user's actions did not match perfectly with what the actually character did, but only roughly.

3) *User control and freedom*

- Since Fighters Uncaged was gesture-based and showed the main character from a third person perspective, the user became more preoccupied with perfecting the commands, so that the application would understand them correctly, than actually controlling the character to accomplish the goals within the game.
- Fighters Uncaged included a guiding agent, but since the user managed to complete the goals without following the guidance, the user began to question the need for it. Even though this created more freedom for the user, it also caused the user to trust the application less. (This also caused a less gain of the competence feeling.)

4) *Consistency and standards*

This heuristic was omitted when reviewing games for the KUI due to the lack of standards at the time of testing.

5) *Error prevention*

- The gesture tracking in Fighters Uncaged was unpredictable and did not recognize all the gestures. Additionally it did not show when a gesture was not recognized, and instead ignored it, which meant that the user was unaware of whether or not his or her gestures were faulty or unrecognized.

5.2 RQ 2: Which conditions are most prominent in facilitating motivation for exercise?

5.2.1 Journals

The journals were dispatched to a total of five participants. They were instructed to write in it every day for seven consecutive days. The ages and genders of the participants were: girl (17-19), girl (20-22), boy (22-24), boy (13-15) and boy (13-15)[26].

Due to the vast amount of qualitative data in the journals they have been compressed and some interesting quotes have been extracted. Some general observations of user needs have also been extrapolated and are presented in this section.

5.2.1.1 Quotes

This is a collection of quotes collected from all five participants. All quotes are translated to English from Norwegian.

- "[…] [She exercises to] feel better with her body."

[26] The ages have been intentionally obfuscated to help reduce the likelihood of the participants being identified, which was required by the Norwegian Social Science Data Services.

- This participant "promised [herself] that she would do it [i.e. exercise]".
- "*Constant external pressure*" and focus on body image negatively impact this participant's exercise motivation.
- A participant likes challenging herself and enjoys the subsequent of "*feeling of mastering something*".
- One participant was especially proud that she "[…] *reached 97% of max pulse and 92% during the intervals*".
- "I felt I just had to start [exercising] again".
- The same participant also pointed out that "[…] having an exercise partner made it easier to motivate her to start exercising again".
- "Exercising makes me feel better about myself and stronger".
- "The sessions are often though and tiresome, but after completing them, I feel great!"
- One participant believes that exercise will "[…] give me a better life on long terms, reducing chances of various illnesses and in addition get better mental health."
- "[I enjoy the] feeling one experiences after an exercise session".
- "I like to exercise when in a social environment with friends".
- "I exercise because I want to get better [at an activity]".
- "I exercise because I had to…"
- The same participant also wrote I "[…] do not feel I have given my best" and "I feel dissatisfied because I do not feel that I gave enough effort".
- "[…] [I] played more soccer. I almost sweat to death".

In summary, it seemed as though most participants' motivation for exercise were internally extrinsic as several stated they exercised for physical and mental health benefits. Others also displayed intrinsic exercise motivation as they cited exercising for improving competence and enjoyed the social environment. Additionally, it also seemed as though some participant's motivation was negatively affected by external pressure. For their original format and more in-depth analysis of each participant's journal, please see the appendices.

5.2.1.2 User needs

This section includes a summary of user needs extrapolated from the journals. The extraction and grouping of the needs were done simply by textually analyzing the qualitative data.

- *Immediate and indicative feedback* – Some participants used exercise as a way to feel better with their bodies, either for health purposes or appearances, which meant that they required indicative feedback of their exercise. They need to know that their exercise sessions were sufficient. One participant mentioned she used a pulse meter to continuously monitor her progress during the exercise session.
- *Feeling of competence* – All of the participants explicitly stated to greatly enjoy the feeling of mastery and competence in the exercise tasks. This meant that they required a constant and indicative feedback of their performance in order to improve.
- *Feeling of accomplishment and confidence* – Some participants stated that they felt pride in their accomplishments. This meant that the challenges needed to match their skill-level for them to continually feel this sense of accomplishment and confidence. This requirement is closely related to the feeling of competence.
- *Guiding agent* – One participant mentioned that her exercise instructor was greatly effective in increasing her exercise motivation, which

suggested that a guiding agent might be beneficial. She felt a stronger need to perform better due to the instructor.

- *Social aspect* – Some of the participants found the social aspect of exercise to be motivating which suggested that a feeling of relatedness might be advantageous to attempt to facilitate. (However, it is interesting to note that prior research has found that relatedness seemed to be of less importance than competence and autonomy. Additionally, studies have found that relatedness functions destructively for persons with low self-efficacy.)
- *Feeling of autonomy* – Some of the participants explained that they did not enjoy exercise sessions they felt pressured to do, which meant that the user needed to feel that their exercise is voluntary.

5.2.2 Personas

From combining the relevant literature and findings from the journals, this thesis developed four personas to be used in the idea generation and concept elicitation phases. Due to the length of their profiles, the four personas can be found in the appendices.

5.3 RQ 3: Which challenges are relevant when exploring the relationship between exercise motivation and feedback from a peripheral KUI application?

5.3.1 Idea generation

5.3.1.1 Forced analogy

First word: play

Words that were associated with "play": dog, sandbox, ball, social, playful, have fun, dirty, happiness, sport, accomplishment, games, team play, childish

From words associated with the first word we developed the following concepts:

- Virtual dog/pet: This concept originated from the word “dog”. It would be similar to the previously popular Tamagotchi game. The idea was to have a virtual pet that required the user to take it on virtual walks or runs regularly. It would rely on the user’s feeling of responsibility to the virtual pet.
- Sandcastle: The user would be awarded for their exercise in terms of sandcastles that they could build in a virtual sandbox. The idea was that it would be similar to existing social mini-games such as FarmVille and would rely on the user establishing an impression of ownership to his or her sandcastles as they were built though hard work. Additionally it would perhaps create a sense of accomplishment in the user as their exercise becomes represented as virtual concrete objects.

Second word: car

Words that were associated with “car”: laziness, travel, race, tinkering, social status, fuel, expensive

No good concept ideas came from the words associated with “car”.

Third word: window

Words associated with “window”: house, look out, mirror image, mirror, washing, cleaning, curtains, more light, protection, dirty, transparent, fragile, open, close

From the words associated with “window”, the following concept ideas were suggested:

- Medical info: It would be like a sci-fi digital mirror that displayed medical info to the user as he or she exercised in attempt to illustrate the biological benefits of his or her current activities. Additionally it could perhaps display calories expended. This would provide continuous and immediate feedback to the user while he or she exercises. Additionally, since the user is made aware of the invisible biological benefits it may create a sense of progression.
- Devil/Angel: The idea spawned from conversations about the user seeing a "better" version of themselves in a mirror, which further developed into an angel on one's shoulder and a devil on the other. The angel would provide positive encouraging feedback while the devil would provide negative feedback in attempt to motivate the user to want to prove it wrong. It was hypothesized that the user would feel a sense of accomplishment if he or she succeeded.

5.3.2 Concept elicitation

This section presents the results from the methods used in concept elicitation. As the concept scoring method requires criteria, this thesis began by prioritizing and selecting the most prominent criteria using the Divide the dollar method.

5.3.2.1 Divide the dollar

Round 1

From the first round it became clear that the needs "Guiding agent" and "Social aspect" were far less important than the remaining needs, hence they were eliminated and the process was repeated with the remaining four needs.

User needs	Intrinsic	Internal extrinsic	External extrinsic	Amotivated	Sum
Immediate and indicative feedback	7	8	11	14	**40**
Feeling of competence	11	8	2	7	**28**
Feeling of accomplishment and confidence	9	12	14	10	**45**
Feeling of autonomy	8	5	6	6	**25**
Guiding agent	2	4	5	0	11
Social aspect	1	1	0	0	2

Table 1: Dived-the-dollar-results (1st round).

A second round was performed to further distinguish the prioritization of the remaining user needs.

Round 2

User needs	Intrinsic	Internal extrinsic	External extrinsic	Amotivated	Sum
Immediate and indicative feedback	12	11	10	9	**42**
Feeling of competence	8	9	7	7	**31**
Feeling of accomplishment and confidence	11	12	9	13	**45**
Feeling of autonomy	1	0	6	3	10

Table 2: Divide-the-dollar results (2nd round).

From the second round it became clear that although the criterion "feeling of autonomy" scored rather well in the first round, it scored considerably worse once the criteria set had been narrowed down.

5.3.2.2 Concept scoring

This thesis performed a concept scoring of the concepts from the idea generation phase. The reference concept that was chosen was "Fitness Evolved". This is a game developed by Microsoft and is one of the first games for Kinect that focuses on exercise. It seemed to be an appropriate reference concept as it (in a way) established an industry standard for exercise-themed exergames.

The weights that were assigned were the results from the divide-the-dollar method and the criteria/user needs were derived from the analysis of the journals.

- User need 1: Immediate and indicative feedback
- User need 2: Feeling of competence
- User need 3: Feeling of accomplishment and confidence

		Fitness Ev.	Medical Info	Virtual Pet	Devil Angel	Sandcastle
User need 1	42	84	210	42	126	42
User need 2	31	62	93	93	62	93
User need 3	45	90	180	135	45	135
		236	**483**	**270**	**233**	**270**

Table 3: Abbreviated version of the Concept scoring table.

From this Concept scoring table, it was obvious that the Medical Info concept was most appropriate for this thesis to continue developing.

5.3.3 User testing

All the participants were aged between 20-25. They were all students at the University of Oslo, ranging from freshmen to PhD students. Some participants were students associated with the field of Interaction Design, while others were not. Some were already familiar with the Kinect camera, while others had never been exposed to it before. The session was performed with a mixture of both pair interviews as well and individual ones. The prototype was unfortunately a bit buggy, which occasionally impacted the results negatively. These issues with the prototype were absent during development and first occurred during the user testing, perhaps due to the different lighting in the testing location.

Participant 1 & 2 – Boys, age 20-25

KUI familiarity: not at all

User testing method: valance method

The first two participants who were tested were good friends who only had a limited amount of time, hence their user testing sessions were merged.

- When asked about their impression of the application's trustworthiness, they both stated a certain doubt in the preciseness of the information received.
- Mentioned that the audio feedback from the prototype was distracting and negatively influenced the game experience.
- They did not understand the purpose of the information, partly because the prototype was too far away, hence too unclear to see.
- One of the participants stated that he enjoyed games that continuously rewarded the user for minor achievements.
- They said that because it was difficult to focus on two screens simultaneously, they would prefer to be presented with the exercise feedback at the end of each gaming session.
- They did not understand the medical information that was presented.

Participant 3 – Girl, age 20-25

KUI familiarity: not at all

User testing method: valance method

- This participant found the audio feedback distracting because she was more focused on the game.
- She said she would prefer to be presented with the exercise feedback at the end of each gaming session.

- This participant did not understand the graphical interface, partly because of faulty readings (due to the bug). She had trouble interpreting the “progress line”, which represented her daily overall exercise progress, as well as the red color occurring when she moved her different limbs. She believed it could be a representation of her body heat, but was not sure.
- The participants also stated that she had difficulties recognizing the purpose of the audio feedback.
- She felt an increased performance while playing without the application compared to including it, due to it being a bit distracting.
- The overall progress bar seemed a bit deceptive, and the Kinect´s inability to deduce a users bodyweight was also mentioned as a disadvantage concerning the trustworthiness of the information.
- When asked what type of feedback she would have preferred receiving, she mentioned information about her weight, resting heart rate and maximum heart rate.
- Though the application may have been able to motivate her to start exercising, she did not find the feedback useful during the exercise session itself.

Participant 4 – Male, age 25-29

KUI familiarity: familiar with Kinect and similar forms of interfaces

Testing method: Follow-up interview

- This participant understood what the audio feedback said after a while. He found it difficult to focus on the audio feedback while playing a game. Additionally, he said that he prefers information presented visually.

- He did not understand much of the graphical interface, partly because it was too far away and he could not make out the individual elements. He said that it would have been better if it were on the same screen as the game instead of a separate screen. He said he understood the information given once he stepped closer to the display.
- The participant felt the information provided was accurate as he said, "[…] it looks that way".
- The participant was, however, unsure how the prototype gathered its data, something that he would have preferred to know.
- The participant also said that at first glance the graphical interface's visual expression gave him the impression it was a "debug screen".
- He additionally speculated that if the prototype included a social and competitive aspect, it might have created more motivation for e.g. his wife.
- This participant seemed very intrinsically motivated towards playing the game.

Participant 5 & 6 – Girls, age 20-25

KUI familiarity: Some familiarity with Nintendo Wii

User testing method: Follow-up interview

- At first, these participants believed that the application was able to generate personalized exercise goals due to the measurements made at the application startup.
- Participant 6 stated that the audio feedback might have been improved if headphones had been employed due to occasionally difficulties of hearing that audio feedback.
- She believed that the application had potential of becoming useful for exercising. The participants also stated that it might have been motivating if the application would have allowed her to monitor her

exercise statistics over time, as well as incorporating some social aspects. Some competitive elements could have made the experience more engaging.

- Despite apparent bugs, one of the participant said she would have found the application trustworthy.
- As for the interface, none of the participants understood what the red fields were suppose to represent, but they guessed it had something to do with the heat of different body parts.
- The participants also had problems reading the information presented due to the users distance from the screen. As a result, the audio feedback became more important.
- One of the participants also suggested that a more realistic projection of the user might have made the application trustworthier, as the experience would have appeared more personalized. In addition, one suggestion was to add some different achievements as well as to provide more feedback on user technique.
- Both participants monitor their exercise habits with the use of alternative equipment. The smartphone app "Runkeeper" was mentioned as well as checking their pulses.
- When asked if the application had any impact on the gaming experience, both participants claimed it did not affect it, neither positively nor negatively.

Participant 7 – Male, age 20-25

KUI familiarity: Familiar with Nintendo Wii, have tried Kinect

Testing method: Follow-up interview

- This participant believed that the main progress bar represented how much he should exercise each day and the smaller ones distributed in the corners were how much he had exercised each limb.
- This participant said "*I understood very little of what she said, […] but I felt it was positive to get that information*". He did, however, understand the audio progress indicators and felt that it resembled an instructor trying to push him, which he said was positive. He also added that it probably could influence him to exercise more when he had a goal to work towards.
- However, he did say that he did not feel any significant difference with the prototype providing feedback while he played compared to without.
- This participant believed that the prototype was accurate in gathering information about him because he saw the red fields on his image when he moved the corresponding limbs. He did add that although he trusted the information, he did not believe it could not be 100% accurate.
- Additionally, the participant said that the prototype was more responsive than other Kinect applications he had tried, which improved his impression of the prototype.
- The participant did add that the prototype was a little distracting to the gaming experience.
- Once the participant stepped closer to the display he said that he could easily understand the graphical interface.

Participant 8 & 9 – Girls, age 20-25

KUI familiarity: not at all

Testing method: Group follow-up interview

- Participant 8 was very engaged in playing the game, but could still make out what the audio comments said. Participant 9 had difficulties understanding the audio comments.
- They both found the graphical interface a bit confusing and unclear.
- They were unsure what the percentage indicators meant.
- They did not understand what the main progress line indicated. They could not tell if it represented the exercise goal or if it were something else.
- Due to some software bugs the prototype processed some faulty readings that made the progress bars fill up much faster than normal. This caused the participants to loose trust in the prototype since it showed that they had exercised when they were actually standing still.
- Furthermore, they firmly believed that such technology could not be accurate since people have very different biometrics. Participant 8 did not trust treadmills either, even after having inputted her weight.
- Additionally, she added that she counts calories and tracks her progress when she runs on the treadmill, even though she says she does not trust the data the treadmill provides her.
- Participant 9 said she would like to know which body parts she exercised more, and she would like to have it presented like a heat-map on her image on the display.
- They did not find the information given to them to be very useful. Participant 8 would instead prefer to know how many calories she had expended.
- The participants also said that the audio feedback might have been useful to them if they had focused more on it during the game.
- In general, they concluded that the prototype did not positively affect their exercise during the gaming session. However, if the information

given was easier to understand, then it might have had positive influence.

- The participants also suggested that they would like to be able to set a goal before a session and work towards that.

A general observation was that many of the participants (mostly those who were unfamiliar with this form of interface) were careful and reserved when testing the prototype. It seemed as though they were afraid of being physically active in this lab setting or unsure how to communicate with the interface when standing several meters away from any physical devices.

6 Discussion

This chapter uses the relevant literature described in the theory chapter to discuss the results procured during this project in terms of the research topics. More specifically the discussions in this chapter are sequentially organized by the research question they are associated with.

6.1 RQ 1: Which aspects are essential for a KUI application to provide a good UX and usability compared with applications with other interfaces?

This thesis has chosen a combination of *usability goals* and *user experience goals*[27] as indicators for measuring different interfaces. In order to investigate which of those aspects are essential for a KUI application compared with other interfaces, this thesis conducted a heuristic evaluation of various applications with different interfaces. The differences are discussed in terms of embodied interaction, which is related to user experience, and Norman's design principles, which are closely related to both usability and the heuristics.

Although this project discovered many design aspects where the KUI differed from both the desktop and multi-touch interfaces, the researchers found the most important aspect to be KUI's ability, and necessity, to provide good continuous and immediate feedback. Feedback was not only evaluated as KUI's advantage, but also as the most essential aspect for a KUI application to provide in order for it to have successful usability and facilitate a good user experience.

[27] These goals are defined in section 2.1 Interaction design.

This section discusses why continuous and immediate feedback was concluded to be the most important advantage, how necessary it proved to be for good usability and a successful user experience and how it was related to the other aspects. The remaining aspects are all discussed in terms of how well the KUI compared to other interfaces and what role they played in determining a good user experience and usability for a KUI application. The final section summarizes and concludes the following discussions.

6.1.1 Mapping

Mapping is described as the logical correlation between the user's actions and the desired effect. For example, if one turns the steering wheel in a vehicle to the right it causes the vehicle to turn to the right. This is logical and such design is considered to be a good map between action and effect.

The evaluators of the heuristic evaluation found for multiple situations that the KUI version was often more sufficient in providing good maps between action and effect. For example, performing a real world "slice"-gesture with the KUI was better corresponding with the "slice"-function than swiping on a multi-touch interface. Additionally, since walking in-place triggered the walk function, it was also found to be a better map between the action and the effect than pressing keys on a desktop interface. This improves an interface's satisfaction of the usability goals learnability and rememberability.

However, the evaluators discovered that once the users were familiar with the logical mapping between real world gestures and application functions, the users began to expect the KUI to recognize all their real-world gestures. Since the KUI was limited to only recognizing some (partly due to technical limitations), the lack of more complete mapping caused frustration and increased error frequency, hence diminishing both the usability and user experience. This thesis, therefore, argues that while a good mapping between actions and effects can improve the usability, it can also spoil a good user experience if the limits of the mapping is not clearly presented to the user, as further discussed in the following section about constraints.

6.1.2 Constraints

The evaluators of the heuristic evaluation found the KUI to be less constraining than the other interfaces. Since the KUI was not limited to a set of buttons or a touchable screen, the evaluators stated they could devote much more focus to their tasks and actions rather than thinking about communicating with the interface, as is the ambition of PUI[28] type interfaces. The evaluators experienced the flow-state much easier with the KUI version of FruitNinja, which was tested on both multi-touch and KUI. Since a user could communicate with the KUI version without translating their desired actions into commands first, such as button presses, taps, or swipes, one could explain that this unconstraining nature of the KUI helped free more mental processing capacity to allow the user to focus on the task. Hence, summarizing that a KUI allows a user's actions to be mapped more directly to the effects[29], one can argue that the less constraining nature of KUI made it less hindering to a user achieving the flow-state, compared to other interfaces. This is indicated by the just-mentioned observations from the heuristic evaluation and also substantiated by the theories pertaining to Flow.

However, considering that the evaluators found the flow-state easier to achieve on the desktop version compared to the KUI version for a different

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[28] Proximal User Interface (PUI) is introduced in the Theory chapter.

[29] This "mapping" is more thoroughly discussed in the Mapping section.

application (Morrowind, KUI vs. desktop), this thesis had to revise the previous conclusion. Part of the reason why the flow-state was easier to achieve with the desktop interface, as reported by the evaluators, was because the evaluators expected the KUI version to create the correct effects for all the actions they performed. Since the mapping between actions and effect was not complete, some actions did not cause any effects, or even illogical effects, the evaluators therefore experienced the KUI version as more prone to user errors, subsequently making it less safe to use. This offset the skill-challenge balance thus prevented flow and consequently caused “worry”, “anxiety”, and “frustration”, as the challenges became greater than the evaluators’ skill-levels. Further, while the less-constraining nature of KUI proved advantageous in the evaluation of FruitNinja for facilitating and sustaining flow, the same less-constraining aspect helped hinder and diminish the flow-state in the evaluation of Morrowind.

This result may seem contradictory at first, but if one considers Norman’s design principle of constraint, an explanation can be deduced. Norman argues that an application should communicate clearly to the user which commands are acceptable in the given context. The second application (Morrowind) did not highlight any constraints, which caused the user confusion and errors as he/she was unsure which gestures would be recognized and which would not. Since the user’s mind had to process this additional uncertainty, it naturally occupied some of the user’s processing ability, thus contributed to hindering the flow-state. Since the application FruitNinja was much simpler and could only accept one command (the “slice”-command), it was naturally more constraining than Morrowind, and the issues with error proneness did not occur. Therefore, the user could benefit from the less-constraining nature of KUI and more easily achieve flow.

In summary, this section has considered constraints on two levels. First, since the KUI offered a more direct mapping between user's actions and effects, it can be regarded as less constraining than some other interfaces, such as multi-touch and desktop. This can benefit a user in achieving the flow-state, as he or she does not have to devote as much mental processing capacity to translate actions into commands. The second level of constraint that is discussed in this section explains that unless the application is very simple, such as FruitNinja, the application needs to abide to Norman's design principle of constraint and impose either physical, logical, or cultural constraints appropriate to the context to highlight where the mapping between actions and effects ends. Since the KUI cannot provide any meaningful physical constraints, it must rely on logical and cultural constraints, both of which require the application to continuously feedback those restrictions to the user.

Hence, one can conclude that to impose constraints on a KUI interface, which is essential for a good user experience and usability, the KUI application requires good continuous feedback. (Please see section 6.1.4 for more discussion about feedback.)

6.1.3 Affordance

Although the observations from the prototype testing were intended for research question 3, the following observation was very relevant for this section. During the user testing of the prototype the researchers made a general observation that the users who were unfamiliar with the KUI often seemed to be reserved and hesitant to move their body. It would be reasonable to consider the alien lab setting as a cause, however, since this observation seemed restricted to those who were unfamiliar with the KUI, another consideration must therefore be regarded. It seemed as though the hesitant users did not know how to start to communicate with the interface. These observations are in accordance with what one would expect if an application offers poor clues to its operation, hence can be regarded as facilitating little affordance in the user.

An application that offers poor affordance of its operations looses the associated advantages; mainly improved learnability. Affordance is also known as stimulus-response compatibility. To overcome this weakness and compensate for the lack of affordance, Norman recommends that such an application must employ additional visual clues and feedback to attempt to advertise its operations, subsequently creating affordance. This is in conformance with the evaluators' observations as they found that applications that did provide good continuous feedback were much easier to learn to use than those that did not. For example FruitNinja on KUI compared to Morrowind on KUI was found to be much easier to learn because it included a good continuous feedback element; the virtual shadow.

In conclusion, the KUI itself can be regarded as poor in facilitating affordance to novice users due to its physical properties, in contrast to e.g. physical buttons. However, the application that uses the KUI can attempt to compensate by striving to cause good affordance through incorporating strong visible clues and good continuous feedback. In other words, the better the *stimulus* the application causes, the more likely the user will return an appropriate *response*.

6.1.4 Feedback

Since the KUI cannot provide direct tactile feedback, which other common interfaces can due to physical input devices, an application with a KUI tends to be more error prone, which the evaluators of the heuristic evaluation found as they were unsure if their commands had been received, in contrast to, for example, sending commands to a desktop interface by pressing buttons. However, the evaluators also found that they were more certain that their commands had been received when a KUI application provided continuous and immediate feedback, as the virtual shadow did in FruitNinja. Hence one interpretation could be that if an application provides immediate and continuous feedback, the lack of expected tactile feedback could be compensated to a certain degree, thus reducing the error frequency, which subsequently makes the application more safe to use. Additionally, a reduction of error frequency helps lower the hindrance for a user to achieve the flow-state as he or she can devote more mental processing capacity to the task at hand. (Feedback is discussed more thoroughly in relation to other aspects in section 6.1.8.)

6.1.5 Embodied interaction

One interesting observation from the heuristic evaluation was that while the KUI versions were less accurate and more error prone than their counterparts, the evaluators found them unanimously more engaging to play. Considering this observation from a usability perspective, these usability shortcomings should be a hindrance for a good user experience. Additionally, considering the SDT, one would assume the loss of control, due to less accuracy, would diminish the feeling of competence, and subsequently reduce the user's intrinsic motivation. Since the evaluators instead found the less accurate KUI versions more engaging to play than their more accurate counterparts, one interpretation would be that the SDT is inappropriate for analyzing this case. If one were to conclude to this interpretation, one would require a theory that explains a correlation between increased motivation and poor usability.

On the other hand, since the KUI required the user to be physically active with his/her body, the psychological framework of embodied cognition explains that such activity impacts the mind. Studies associated with the field of embodied interaction have shown that such impact tend to improve the users' learnability and rememberability as well as positive emotion, motivation and self-efficacy. A second interpretation could be that the improvement of the usability goals of learnability and rememberability outweighed the issues with accuracy. Additionally, considering the autonomous nature of KUI (i.e. the user communicated using his/her entire body as discussed more thoroughly in the Constraints section), one can employ the SDT and argue that it caused a feeling of autonomy that overtrumped the slight loss of competence (due to the lack of accuracy). This increase of autonomy consequently facilitated an increase of intrinsic motivation. This interpretation is also in accordance with the theory of embodied interaction. Hence, this thesis concludes that although the KUI has some usability shortcomings, its nature tends to facilitate a better user experience.

In addition, this project also observed a case where the shortcomings in accuracy and control were not outweighed by the positive effects of embodied interaction. The evaluators of the heuristic evaluation found that the lack of accuracy and control negatively impacted the feeling of expected autonomy inherent in the nature of the KUI. This observation shows that the previous conclusion requires a condition, and must hence be reformulated. This thesis therefore concludes that although the KUI has some usability shortcomings, its nature tends to facilitate a better user experience, *only if* the usability shortcomings are minor enough that they can be outweighed by the induced usability and user experience advantages caused by embodied interaction.

Furthermore, the evaluators found while evaluating the existing KUI game (Fighters Uncaged) that because it did not provide immediate and continuous feedback to the user about which actions were accepted and which were not, it amplified the feeling of the user having little accuracy and control. This finding is in accordance with Rosson's and Carroll's claim that operations that require higher accuracy and control depend on extensive and accurate feedback. Hence, this thesis acknowledges that immediate and continuous feedback is essential for a KUI application to avoid substantial issues with accuracy and control, which in turn allows the induced usability advantages of embodied interaction to overtrump them.

6.1.6 Visibility

If a user can elicit an application's functionality simply by looking at it, that application is, according to Norman, considered to have good visibility, and may consequently facilitate affordance within the user. Hence, the advantages in terms of usability are that such an application becomes easier to learn.

The researchers could not find any examples of good visibility in the first two games (Morrowind and FruitNinja) evaluated across different interfaces. Although some aspects contributed to better learnability in those games, it was difficult to credit good visibility as the cause. However, the researchers did find the last game (Fighters Uncaged) to have good visibility as it displayed visual clues of the commands it could accept from the user. Even though this contributed to improving the learnability of the game, the evaluators found that other factors greatly diminished it, most significantly the lack of good continuous feedback.

6.1.7 Consistency

If an application's interface is consistent with its peers, its advantage is that it often becomes easier to learn and use for a user, assuming the user is already familiar with similar applications. However, since the KUI (at the time of writing) was relatively new, KUI applications had few peers to be consistent with. Hence it is easy to assume that it was insufficient in satisfying the usability goals: learnability and rememberability. However, considering that the evaluators found the KUI versions almost as easy to learn compared to their counterparts, one must assume that other aspects satisfy the usability goals of learnability and rememberability. Those aspects include affordance, feedback and embodied interaction.

6.1.8 Summaries and conclusions

This thesis found multiple aspects where the KUI proved both unique and advantageous compared with other interfaces. For example, it was evident that the KUI often allowed a better mapping between actions and effects compared with other interfaces. However, while this mapping was positive in improving the learnability and rememberability of the application, it also proved troublesome as the lack of physical constraints caused users to expect a more comprehensive mapping, an expectation that was left unfulfilled. Although this lack of constraints helped cause such issues, it was also an aspect that contributed to the user reaching a flow-state. Hence, this thesis argues that while one of KUI's assets is its less-constraining nature, it still needs to establish some constraints to emphasize the limits of the interface and prevent user frustration. This establishment of constraints can be achieved through good visibility and feedback.

Additionally, since the KUI was evaluated to have comparatively worse affordance than its counterparts, it resulted in reducing the learnability of those applications. To compensate for the loss of learnability a KUI application can attempt to facilitate good and comprehensive stimulus through strong visual clues and good feedback to hopefully achieve the relevant user response, thus promoting affordance.

Furthermore, this thesis reasoned that good continuous feedback was paramount in reducing the KUI's usability issues with accuracy and control. Those issues needed to be reduced so that they could be overtrumped by the induced usability advantages of embodied interaction, and subsequently a user could experience the accompanying motivational advantages.

While the visibility and consistency aspects were important to a successful user experience and usability, they were not specifically related to the KUI. They were instead more general and apply to all the evaluated interfaces and were hence comparatively less appropriate answers to the research question. Considering that good feedback is essential for employing constraints, facilitating affordance, and encouraging the advantages of embodied interaction, this thesis found that good continuous feedback to be the most essential aspect for a KUI application in order to have a good usability and facilitate a good user experience.

6.2 RQ 2: Which conditions are most prominent in facilitating motivation for exercise?

In order to investigate the relationship between the KUI and exercise motivation, this thesis found it relevant to attempt to understand the conditions that facilitate such motivation.

From the literature review, this thesis found that the conditions most prominent in facilitating exercise motivation are – according to the SDT – the feelings of competence, autonomy, and relatedness. Some literature also described a link between self-determined motivation and high self-efficacy, which is closely related to confidence. Furthermore, additional literature ascertains that there is also a correlation between self-determined motivation and frequencies of flow. However, to be able to extract the most prominent factors, and the aspects that might have induced those factors, this thesis has dispatched journals to five youth participants to collect qualitative data pertaining to their exercise motivation.

This section discusses the findings in terms of SDT, self-efficacy, and flow. This thesis also attempts to deduce the aspect that seemed most prominent, and which aspects that may have some influence.

Two of the participants credited the feeling of relatedness as a partial cause for exercise motivation. One stated that he enjoyed exercising in a social environment with friends while the other pointed out that "[…] *having an exercise partner made it easier to motivate [her] to start exercising again"*. While it would be possible to consider relatedness to be partially evident in facilitating exercise motivation, the results from the journals indicate that other aspects are more prominent. This is in correspondence with SDT literature that evaluates relatedness as less significant compared with competence and autonomy. Additionally, both self-efficacy and flow are rarely discussed in respect to relatedness.

Considering that many of the participants tended to write statements such as: "*The sessions are often tough and tiresome, but after completing them, I feel great!*" and "*[I enjoy the] feeling one experiences after an exercise session*" this thesis must consider the link between surmounting a challenge (the challenge being completing an exercise session) and the positive feelings after. This observation is in accordance with the concept of self-efficacy, which explains that people who manage to tackle challenges often experience an increase in confidence, and a sensation of accomplishment, which are some characteristics of increased self-efficacy. By tackling the challenge they experienced a sense of mastery and gain in competence that, in accordance with SDT, helps increase their self-determined motivation. This link between self-determined motivation and self-efficacy has also been explored and confirmed by other studies[30]. Hence, this thesis argues that the feeling of competence – partially composed of the feelings of accomplishment, seems to be the most prominent condition in facilitating exercise motivation. Two participants further support this argument by explicitly writing: *"I exercise because I want to get better [at an activity]"* and *"[I enjoy the] feeling of mastering something"*.

In addition to the apparent link between competence and accomplishment, this thesis also recognizes the intertwined nature between competence and autonomy. As the SDT literature has found, a feeling of competence is only experienced and effective in inducing motivation if it is accompanied by a feeling of autonomy. In other words, the person must feel as though he/she determined to gain that competence him-/herself. An instance of the inverse is also found in the journals-data. A participant who wrote *"I exercise because I had to…"* could be considered subjected to non self-determined motivation, which would suggest the removal of autonomy also removed his feelings of competence and accomplishment. This is supported as he further expressed dissatisfaction with his exercise efforts, *"[…] do not feel I have given my best"*,

[30] Please see the section 2.7 Motivation for more.

which influenced his mood "*I feel dissatisfied [...]*". This result confirms the literature that a reduction of autonomy compromises a potential experience of competence and accomplishment.

Therefore, considering these findings as well as the literature, this thesis argues that although a feeling of competence must be accompanied by an impression of autonomy, and is often accompanied by a feeling of accomplishment, the feeling of competence is still considered to be the most prevalent condition in facilitating exercise motivation.

6.3 RQ 3: Which challenges are relevant when exploring the relationship between exercise motivation and feedback from a peripheral KUI application?

Since the subject of this thesis was to perform a pilot explore of the relationship between KUI applications and exercise motivation, this thesis found it reasonable to primarily focus on the potential challenges relevant to such an exploration rather than the effects on exercise motivation. This was found prudent since the applicability of any conclusions from such a study would be limited by the modest population size.

To explore this research question this thesis found it reasonable to attempt to combine feedback with the conditions most prominent in facilitating exercise motivation in a peripheral application. Afterwards, this thesis would observe the effects on youth and record any outstanding aspects. From research question 1 this thesis found that good continuous and immediate feedback was the most essential, and also the most advantageous aspect of the KUI. This thesis concluded, from investigating research question 2 that the most prominent condition for facilitating exercise motivation was to create the feeling of competence within the user. Hence, this thesis attempted to develop a prototype of a peripheral KUI application that focused on providing good feedback about aspects that might cause the user to feel a gain in his/her competence of exercise.

In order to develop a concept from which to create a prototype, the researchers found it prudent to invite external potential users to an idea generation session. Concepts from that session were then evaluated in the concept elicitation phase before development of a prototype began. Through these processes the thesis also employed the four personas (who were based on the findings from RQ 2) to provide constant reminders of this thesis' understanding of the target group. Lastly, the results from the user testing of the prototype were collected and discussed with regard to the research question.

Although the test subjects gave the impression that they desired feedback about their exercise while interacting with a KUI application, it was obvious that actually providing that feedback was more intricate than assumed. This section discusses three main challenges that were observed in the results.

6.3.1 Feedback overload

A consistent observation was that the test subjects simply did not understand or grasp the information given by the prototype. However, there was a division between the test subjects. The difference was that the first group said that they simply neglected the prototype in favor for the primary application while the second group said the prototype disturbed their focus of the primary application. More so, the first group said they could grasp that the prototype was providing them with some information, but they could not understand what that information was. They said they were simply too focused on the primary application that the peripheral one was neglected. The second group, on the other hand, said that the prototype was distracting and disturbed their focus of the primary application. Common for both groups was that everyone expressed some difficulties with comprehending the information given by the prototype. The test subjects' difficulties ranged from some who did not understand the information at all to others who understood it, but disregarded it.

One of the characteristics of a person reaching the flow-state is that he/she is so focused on a task that he/she becomes unaware of external unrelated stimuli. Considering that the first group could not understand the information given by the prototype because they were so focused on the primary application, it would be reasonable to assume that they were in the flow-state, and the prototype had no effect. The continuous and immediate feedback about their exercise from the prototype was simply ignored.

Furthermore, to explain the second group's statements, one must consider that cognitive psychologists have found that the human mind has an upper limit of how much information it can process simultaneously. Considering that these test subjects found the peripheral application distracting, one could argue that the total amount of feedback from both the prototype and the primary application exceeded this limit. Hence, these test subjects could not reach the flow-state as two applications were competing for their focus. This indicates that additional continuous and immediate feedback (which is a condition for flow) can actually be destructive to the flow state if it overflows the user's cognitive processing capacity.

In summary, this interpretation concludes that by providing feedback to facilitate exercise motivation in a peripheral application, the feedback could actually overload the user's processing capacity and in effect be preventative of him/her reaching a flow-state in the primary application. Additionally, this thesis also found that the prototype was often ignored if the user actually had managed to reach the flow-state. Hence, one possible perspective appropriate for considering is that exercise feedback provided through a peripheral application has no effect, and sometimes even negative effects on the user's exercise motivation.

However, despite the fact that the test subjects found the prototype's feedback both ineffective and difficult to understand, no one stated they did not want such feedback. Some test subjects even suggested alternative methods for providing it. Hence, it is clear that it was the way the feedback was provided that was problematic, not the feedback itself. Thus, one challenge relevant for consideration, if one were to further explore the effects of feedback from a peripheral application on exercise motivation, is to regulate that extra feedback to prevent overloading the user's cognitive processing capacity.

6.3.2 Usability issues

During the user testing several issues with the prototype's usability were also uncovered by the test subjects. Most of these issues seemed to be due to the combination of a peripheral and a primary application. For example, the immediate and continuous visual feedback and the occasional audio feedback from the prototype either had no effect or was considered distracting to the test subjects while they were interacting with the primary application, as their focus had to be constantly shifted between the prototype and the primary application. Furthermore, after the primary application had been switched off, the test subjects were asked what they thought each of the prototype's visual components represented and what information it provided. Many of the test subjects were both hesitant and unsure, and sometimes even guessed the wrong answer. As a matter of fact, one test subject even requested information that the prototype already presented. These results clearly indicated that the usability issues that arose from combining a peripheral and primary application were substantial enough that they most likely influenced the users' ability to understand the peripheral prototype's information.

Some of the usability challenges that were discovered were that due to the size of the prototype's display and the distance between the display and the user. Many of the visual elements were too small for the users to see. This naturally contributed to lowering the prototype's visibility (stimulus), hence rendered its feedback (response) incomprehensible, thus also lowering its affordance. Although the prototype did provide good feedback that caused the users to understand that the visual representation was indeed a representation of them, other visual elements were too difficult to perceive that they could not understand the information the prototype attempted to communicate. Hence, the prototype's learnability and affordance was negatively affected by its lack of visibility, which in turn negatively affected the effectiveness of its feedback. This is in accordance with Norman's design principles. Thus, one usability challenge relevant for consideration is the distance between the user and the size of the screen.

Another observation from the user testing was that users who were unfamiliar with this type of interface did not understand how the prototype gathered information about them, and hence did not trust the feedback that the prototype provided about their exercise. Although this observation was less prevalent with users who were familiar with this interface, it is nonetheless important to consider that the prototype might not be good enough at communicating trustworthiness. This aspect could perhaps have been communicated better if the prototype had been more verbose in how it collected and calculated the information. In other words, if it had had better visibility of how its functions operated it might have been more sufficient in satisfying the usability goal: safe to use, hence caused the users to devote more trust to it. This is in accordance with Hassenzahl's and Tractinsky's claims[31] (amongst others) that poor usability might negatively influence the user experience.

Even though there is a distinction between an application's usability and user experience, it is well accepted that the usability impacts the user experience. Considering that the most agreed upon, and even standardized definition of usability is *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction"*[32], it is reasonable to conclude that the prototype's poor usability was perhaps a hindrance for a good user experience. However, it is difficult to speculate if the prototype would have provided a good user experience had the usability been good.

Hence, this interpretation concludes that during the exploration of how feedback from a peripheral application could facilitate exercise motivation, a relevant challenge was discovered, specifically the nature of combining peripheral and primary applications. This combination caused new and significant usability issues, which hindered a good user experience that in effect prevented any facilitation of exercise motivation. Hence, it is reasonable

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[31] Please see section 2.2 for more about user experience.

[32] Please see section 2.3 for more about usability.

to summarize that another relevant challenge when exploring the relationship between exercise motivation and feedback from a KUI application, is how that feedback is provided. Not only must that feedback be regulated as to not overflow the user's cognitive processing capacity, but it must also be presented in such a form that it does not cause additional usability issues.

6.3.3 Weaknesses with the user testing method

A third observation that this thesis discovered was that the methods employed for user testing the prototype might have been flawed, which in turn might have affected the collected results.

Prior to the test, the researchers had prepared to use the fairly new valence method for user testing. It had been developed to test, not only usability, but also user experience. Furthermore, it was designed to have as little influence as possible on the user experience, and was therefore deemed appropriate for this thesis. However, since the valence method required the users to click two buttons during the exploration of the application, and that was impractical considering that the application had a KUI interface that required the users to move all of their body, the exploration and interview phases were merged. This meant that the test subjects were asked to discuss their thoughts whenever they got either a negative or positive impression related to the prototype.

While this modified method was appropriate in theory, the researchers quickly discovered that the test subjects seemed very hesitant to speak. Furthermore, since they were given very little information about the prototype and its goals beforehand, the test subjects showed uncertainty about the purpose of the prototype, which resulted in a lot of irrelevant discussion from the test subjects. Due to these difficulties, the researchers decided to switch to a more familiar method of testing and instead conducted follow-up interviews after the first three test subjects. Although the modified valence method may have affected the result, its impact was however limited to the first three test subjects. Additionally, once the researchers switched to conducting the follow-up interviews, the subsequent feedback from the remaining test subjects were much more relevant to the prototype.

Another issue that was not considered by the researchers prior to testing was that the prototype was displayed on a small 24″ screen next to a rather large 42″ screen devoted to the primary application. Due to the technical limitations of the KUI camera devices, the test subjects had to stand a few meters away from the screens. This naturally made it difficult for the test subjects to see anything on the smaller screen. In effect, this emphasized, and caused, some of the usability issues the test subjects had with understanding the information from the prototype. Moreover, one test subject actually said that he could understand the prototype's information much easier once he took a few steps closer. Hence, if the prototype had been on a larger screen, some of the apparent issues might not have occurred.

A third factor that could have impacted the results was that a previously undetected software bug in the prototype caused the exercise progress bars to suddenly jump up, and then fill up quicker than intended. This might have affected the user experience of the prototype as many of the test subjects expressed concerns with the validity of the information provided. A few of the test subjects even said that since they saw the progress bars fill up by themselves without their contribution, they had difficulties in trusting the feedback the prototype gave them, as that feedback was non-correspondent to their interactions.

A fourth and final aspect that requires consideration was that many of the test subjects were unfamiliar with this form of interface. As a matter of fact, the researchers discovered that those who were familiar with the KUI tended to have a more positive impression of the prototype. They tended to understand and trust more of the feedback it provided. Furthermore, they were also able to comprehend more of the information from the peripheral prototype while interacting with the primary application. Considering this aspect, it might be reasonable to assume that the test subjects who were unfamiliar with the KUI might have emphasized some of the issues that were found during the user test.

In summary, there were a few weaknesses with the user testing that might affect the results when exploring the relationship between exercise motivation and feedback from a peripheral KUI application. The choice of the valence method most likely increased the first three test subjects' uncertainty and difficulties with the prototype. It is difficult to speculate whether or not the regrettable setup where the prototype was displayed on a far too small screen caused any of the usability issues, but it clearly emphasized them. Additionally, the software bug that influenced the prototype's readings almost certainly impaired some of the test subjects' experience, and finally, the fact that many of the test subjects were unfamiliar with the KUI probably further emphasized some of the issues. Thus, an apparent challenge for consideration when exploring this relationship between exercise motivation and feedback is the user testing methods employed.

Hence, while exploring the relationship between feedback from a peripheral KUI application and exercise motivation, this thesis found that the actual testing of the peripheral application proved challenging and more confounded than anticipated. Consequently, one should consider not only the setup of the peripheral application, but also how familiar the test subjects are with the KUI. Additionally, it is also important to select/develop a method appropriate for determining the user experience.

6.3.4 Summary

During the exploration of how feedback from a peripheral application could facilitate exercise motivation, this thesis found multiple challenges relevant for consideration. First, the act of combining a peripheral application with a primary one proved more complex than assumed. The feedback from the peripheral application was either ignored, considered distracting, or the combination even had substantial usability issues that prevented the information from being understood. Furthermore, this thesis also found that testing such a prototype was very intricate. In order to examine the effect on exercise motivation, an appropriate user experience testing method needs to be employed. In order to focus the results to the research topic, the test subjects' familiarity with the commercially new KUI needs to be considered. Finally, in order to test the combination of a primary and peripheral application, the setup of the devices and screens in the lab needs especial considerations.

In conclusion, although this thesis primarily found relevant challenges for exploring the relationship between exercise motivation and feedback from a peripheral KUI application, some data was still relevant to the relationship. Since none of the test subjects protested against the exercise feedback, and considering that some even suggested alternative methods of providing it, it is reasonable to postulate that the users' desired exercise feedback, and that that feedback might facilitate exercise motivation. However, to confirm that conjecture and explore how it can be provided through a peripheral KUI application still requires more research.

7 Conclusion

The topic of this thesis was the exploration of the relationship between KUIs and exercise motivation in youth. As a means of exploring this relationship, this thesis found it prudent to divide the research focus into three research questions, whereas the first was the following.

7.1 RQ 1: Which aspects are essential for a KUI application to provide a good UX and usability compared with applications with other interfaces?

The purpose for exploring this research question was to deduce how the KUI was different from, or similar to other interfaces. Hence, to investigate the differences and similarities, this thesis performed a heuristic evaluation where the KUI was evaluated alongside multi-touch and desktop interfaces. From this study this thesis found KUI's ability and necessity to provide good continuous feedback to be its most outstanding advantage.

7.2 RQ 2: Which conditions are most prominent in facilitating motivation for exercise?

After having explored the differences and similarities between KUIs and other interfaces, this thesis attempted to understand the motivational conditions for exercise from both reviewing literature and collecting data through journals. The purpose of this investigation was to elicit the most prominent conditions in the facilitation of exercise motivation. This thesis later attempted to explore how those conditions could be facilitated through good continuous feedback from a KUI application. The collected data combined with the literature indicated that the feeling of competence was found to be most significant.

7.3 RQ 3: Which challenges are relevant when exploring the relationship between exercise motivation and feedback from a peripheral KUI application?

The results from the two previous investigations were then combined and examined, with the help of multiple methods such as a brainstorming session, personas, concept elicitations, prototyping and finally user testing. The purpose of this final investigation was to explore the challenges of facilitating a relationship between an application with a KUI and its user's exercise motivation.

From the applied research methods, a prototype was developed. This peripheral prototype was designed to provide good continuous and immediate feedback about the user's exercise to induce feelings of competence. From this final exploration, the researchers discovered that providing feedback from a peripheral application was more intricate than considered, as well as testing the effects. It became apparent that a combination of peripheral and primary application could provide an overload of feedback that was either ignored, due to a person being in a flow-state, or even worse, it might even interfere with the flow. New and significant usability issues also arose with the combination, as the users' focus was divided between two applications. Furthermore, several aspects complicated the user testing. First, choosing an appropriate method for investigating the user experience in addition to the usability was problematic, especially for the KUI. Also, since the prototype was a peripheral component next to a primary application, the setup of the equipment needed further regarding. Finally, when testing a commercially new interface, the test subjects' prior familiarity needed to be considered to collect more relevant data. Hence, this thesis' main contributions to the field of interaction design are these findings, which are relevant for others who aim to explore the relationship between exercise motivation and feedback from a peripheral KUI application. However, despite these apparent difficulties, ample evidence was collected that might have indicated a positive correlation between exercise feedback and facilitation of exercise motivation in youth with a KUI application. Nonetheless, this correlation needs further exploration.

In conclusion, the results from these investigations provided insights into how KUIs are compared with other interfaces, how exercise motivation is best facilitated in youth, and finally it illuminated some other challenges that might influence the exploration of the relationship between exercise motivation and the Kinetic User Interface.

7.4 Further work

The researchers behind this thesis regard this project as an exploratory study in the exploration of the relationship between exercise motivation and feedback from a peripheral KUI application. Although a full project lifecycle was completed – from collecting data about users to finally testing a prototype – the quantity of participants was modest. Furthermore, although the researchers' original ambition was to develop and test a prototype and observe its effects, the execution proved more intricate and complicated than first assumed. Since this thesis focused on illuminating the challenges relevant for such a study, the next logical step would be compensate for those aspects and attempt to conduct it. Thereafter, to confirm the results it would be contemplative to increase the extensiveness by including more participants while considering the encountered challenges.

Additional aspects that are interesting for further work could be to research the apparent difficulties of developing applications intended to be complimentary to a primary application. This thesis found many usability aspects relevant for more comprehensive review. For example, the degree of dominance of such an application is interesting to discuss. Further, it would also be interesting to examine how those forms of applications should attempt to communicate with the user, considering this thesis found visual feedback to be problematic.

Furthermore, the KUI is still fairly new, and although this thesis has examined it against other interfaces, this examination could be further extended and further formalized. As interaction designers are interested in the interaction between the application and its users, any device that can impact that interaction is naturally of great interest. The buttons on the keyboard allows the application to understand one-dimensional binary signals from the user. The mouse lets the user communicate with a single point in two-dimensions. Multi-touch screens not only increased the number of interaction points, but they also brought the user’s hands physically closer to the application’s interface. Microphones and mobile computers allowed the application to hear and know where the user was, and finally today’s KUI devices allows the application for the first time, in any meaningful sense, to actually see him/her. And the relationships this interaction allows needs to be further studied.

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Appendices

Appendix A: Prototype

Video of the final prototype: http://vimeo.com/40804586

Video of an early version: http://vimeo.com/33022028

Source code: https://bitbucket.org/mqchen/digitalmirror

To install and run the prototype with Eclipse:

- Install Eclipse
- Install Proclipsing (Processing Eclipse plugin):
  http://code.google.com/p/proclipsing/wiki/GettingStarted
- Install SimpleOpenNI: http://code.google.com/p/simple-openni/
- Download source code and open the project with Eclipse
- Connect Kinect and run project from Eclipse

Appendix B: Journals

Page 1

Hei!
Vi jobber med et prosjekt om ungdommer og fysisk aktivitet, så i denne sammenhengen ønsker vi å bli bedre kjent med deg og dine treningsvaner. Dine svar er helt anonyme, private og er på ingen som helst måte en evaluering av deg, så svar gjerne så ærlig og så utfyllende du føler deg komfortabel med!

I denne pakken finner du en liten trenings-dagbok som du kan beholde og ta med deg rundt i syv dager. Det er noen oppgaver for hver dag, men de tar kun fem minutter å svare på! I tillegg hadde vi satt pris på om du kunne skrive ned hver gang du har gjort noe fysisk aktivitet (tidspunkt, lengde, aktivitetstype og noen adjektiver som beskriver dine følelser og forventninger før og etter aktiviteten). Vi hadde også satt pris på om du kunne skrive ned tidspunkt, situasjon og tankene dine hver gang du vurderer å trene, men bestemmer deg for å ikke gjøre det.

19:30 - 1 time - Fotballtrening

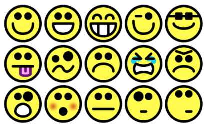
Før trening:
Jeg føler meg: *veldig giret, energisk og rastløs.*
Jeg drar på trening fordi: *jeg føler en plikt til laget. Jeg vil bli sterkere.*

Etter trening:
Jeg føler meg: *avslappet, sliten, tilfreds*
Jeg er fornøyd/misfornøyd med denne treningen fordi: *misfornøyd fordi jeg ønsker at jeg kunne ha gitt mer. Fornøyd fordi jeg føler meg litt sterkere.*

Når syv dager har gått så kan du putte dagboken i konvolutten og sende den tilbake til oss! Som takk for din hjelp har vi lagt ved litt godteri og et kinogavekort. Takk på forhånd!

Page 2

Hvordan *føler* du deg i dag?



Ring rundt så mange du vil!

I dag har jeg...

Ring rundt det du har gjort!

trent spilt dataspill sett film/tv spist usunn mat
spist sunn mat jobbet/skole slappet av vært sosial

Skriv inn det som mangler!

Jeg hadde trent mer i dag hvis dette ikke hadde skjedd!

Skriv eller tegn hva du vil!

Page 3

Er det noe du misliker ved trening?

Skriv eller tegn hva du vil!

Page 4

Mine rollemodeller

Skriv navn og egenskaper til maks 5 rollemodeller som du ser opp til. Rollemodellene kan være hvem som helst, og egenskapene kan være alt fra fysiske til personlige.

NAVN	EGENSKAP(ER)

Page 5

Musikk

Forestill deg at du skal på trening. Hvilken sang representerer ditt humør?

Forestill deg at du er på trening. Hvilken sang representerer ditt humør?

Forestill deg at du nettopp har vært på trening. Hvilken sang representerer ditt humør?

Page 6

Er det noe du liker ved trening?

Skriv eller tegn hva du vil!

Page 7

Hva forbinder du med trening?

Sett en sirkel rundt de 5 ordene du forbinder mest med trening.
Sett en rektangel rundt de 5 ordene du virkelig ikke forbinder med trening.

slitsomt fri givende negativ kjedelig morro ren sunn vanskelig modig god sur glad
enkelt spinkel dumt flink irritert livlig ung vill langsom unormal kort optimistisk lang
sterk svak lydig sosial barnslig varm tilstrekkelig feminin positiv usikker strålende
tung komplett rask tykk vondt frisk bortkastet normal slank orginal sint tom
avslappet sikker opptatt stresset råtten smart uutnyttet våken stolt ensom populær
effektiv mannlig profesjonell interessant menneskelig merkelig frivillig

Page 8

Beskriv noe som fikk deg i bedre humør denne uken:

Skill eller tegn hva du vil!

Page 9

Beskriv noe som fikk deg i værre humør denne uken:

Skill eller tegn hva du vil!

Appendix C: Journals analysis

Participant 1 – Girl, age 17-19

Using the SDT's distinctions between various forms of extrinsic motivation, it appears that this participant's exercise motivation is mainly internal extrinsic. She explains that some of her motivation prior to an exercise session is because she wants to "[…] *feel better with her body*". Additionally she feels obliged to exercise due to a previously unhealthy lifestyle during the preceding period, and even during occasions when she felt amotivated to exercise she pushes herself because she "*promised [herself] that she would do it*". Additionally, and interestingly, during the days she did not exercise she felt a form of guilt to herself, but following the day she managed to push herself to exercise she felt no guilt but instead proud of her accomplishment on the previous day. It appears that tackling that challenge raised her self-confidence and self-efficacy. Furthermore, she tended to have positive expectations prior to exercise sessions and she stated she experienced a sense of satisfaction with herself afterwards, which might indicate that her self-efficacy is relatively high.

In addition, she is acutely aware that external extrinsic factors negatively impact her exercise motivation as she explicitly states that she dislikes the "*constant external pressure*" and focus on body image often associated with exercising. However, she states that she likes challenging herself and enjoys the subsequent of "*feeling of mastering something*". Considering these statements, and that her exercise is autonomously determined, it appears that the SDT provides an adequate explanation for her motivation. Her self-determined (mainly internal extrinsic) motivation is closely related to a combined feeling of competence and autonomy. In addition, self-determined motivation tends to be accompanied with high self-efficacy, which is correspondent with the interpretation of this case.

This participant also states that her fitness instructor was greatly effective in motivating her to perform better during exercise sessions, which could suggest the importance of a guiding agent. Furthermore, she even wrote that she was specially proud that she "[…] *reached 97% of max pulse and 92% during the intervals*", which might indicate that she appreciated a quantifiable measurement of her effort and progress, which in turn creates a feeling of mastery/competence. This shows that immediate and relevant feedback during exercise is of importance for this participant.

Participant 2 – Girl, age 20-22

After reviewing this participant's cultural probe, her exercise pattern and frequency indicates the orientation of her exercise motivation. She states that if it was a while since her last exercise session, she had to actively force herself to go to the gym writing, "*I felt I just had to start again*". On the other hand, if she had established a regular exercise schedule, she actually felt more motivated to exercise. She also pointed out that "[…] *having an exercise partner made it easier to motivate her to start exercising again"*, which could indicate that relatedness could be a motivating factor for her. When asked to describe what she liked about exercising, she stated, "*Exercising makes me feel better about myself and stronger*". In addition, she said that "*The sessions are often though and tiresome, but after completing them, I feel great!*" This suggests that by overcoming these types of challenges it satisfies her innate need for competence (as described by the SDT). Additionally, it appears to increase her self-confidence and self-efficacy. In addition, the participant also expresses that she believes exercise will *"[…] give me a better life on long terms, reducing chances of various illnesses and in addition get better mental health."*

Considering this participant's exercise pattern, frequency and cause of motivation, it is reasonable to consider her exercise motivation to be mainly internal extrinsic. This is partly because she cites external goals such as health and self-esteem as the motivating factors. Additionally she never states that she regards the exercise itself to be enjoyable or fun. Furthermore, it is reasonable to assume that by tackling the challenge of forcing herself to exercise even when she did not want to, increased both her self-confidence and the feeling of competence, which in turn induces self-efficacy and self-determined motivation, which again increases the probability of increased exercise motivation, which is correspondent with the observations of this case.

Participant 3 – Boy, age 22-24

From reviewing this participant's cultural probe it is evident that he was significantly less committed to exercise during the given period, partly due to conflicting practical factors. In fact, he did not exercise at all during the data collection period. It would be very interesting to consider the reasons why someone might fail to motivate him or herself to exercise, but unfortunately this participant only contributed feebly to the cultural probe. Nevertheless, from the collected information he stated that when he does exercise, he enjoys the "*feeling one experiences after an exercise session*". Additionally, and similarly to participant 1, he also appreciates the challenging aspects of exercise. Furthermore, in addition to referring to detached goals such as building a strong and slim body, he also referred to the social aspect as another supplementary condition for exercise motivation. Considering these observations one could perhaps reason that although this participant was amotivated to exercise during the data collection period, he associates exercise with achieving separate self-defined goals, and recognized the significance of relatedness as a motivating factor as well as the sensation of being able to tackle challenges. Tackling challenges is also related to the innate need for competence, as described by the SDT. Moreover, he referred to the positive feeling of accomplishment after an exercise session as enjoyable, which can be interpreted as a cause of increased self-confidence and self-efficacy.

In summary, although this participant was amotivated to exercise during the data collection period, he argued that the most effective factors for increasing his exercise motivation were relatedness, competence and the feeling of confidence acquired afterwards.

Participant 4 – Boy, age 13-15

Considering the data gathered from this participant´s cultural probe, it is reasonable to assume that his motivation for participating has been mainly extrinsic. This can be assumed by the lack of written information in the cultural probe in addition to undetailed answers. Despite the limited information, there are still some interesting facts that can be extracted.

Relatedness seemed to be a motivating factor for him as he wrote: *"I like to exercise when in a social environment with friends"*. Furthermore, he mentions competence as an additional reason for him to exercise: *"I exercise because I want to get better [at an activity]"*. On the other hand, he also stated that he completed another exercise activity solely because he was externally pressured, "*I exercise because I had to…*" In addition, the data collected shows a relation between his mood and his expectations regarding his own accomplishments. On several occasions, he expressed dissatisfaction with his efforts, *"[…] do not feel I have given my best*", which influenced his mood "*I feel dissatisfied because I do not feel that I gave enough effort*". These findings suggests that his innate desire for relatedness and competence increased his motivation for exercising, while a removal of the feeling of autonomy due to external pressure seemed to reduce his intrinsic motivation. This suggests that exposing this participant to external extrinsic motivation was destructive to his intrinsic motivation. Furthermore, it seems that a failure to acquire competence reduced his self-confidence and self-efficacy as he felt he did not perform adequately. These findings are in correlation with the theories around motivation and self-efficacy.

Further, this participant associates exercise to be social, voluntary and positive, which is in contrast to participants 1, 2 and 3 who associates it with detached goals such as health, strength, etc.

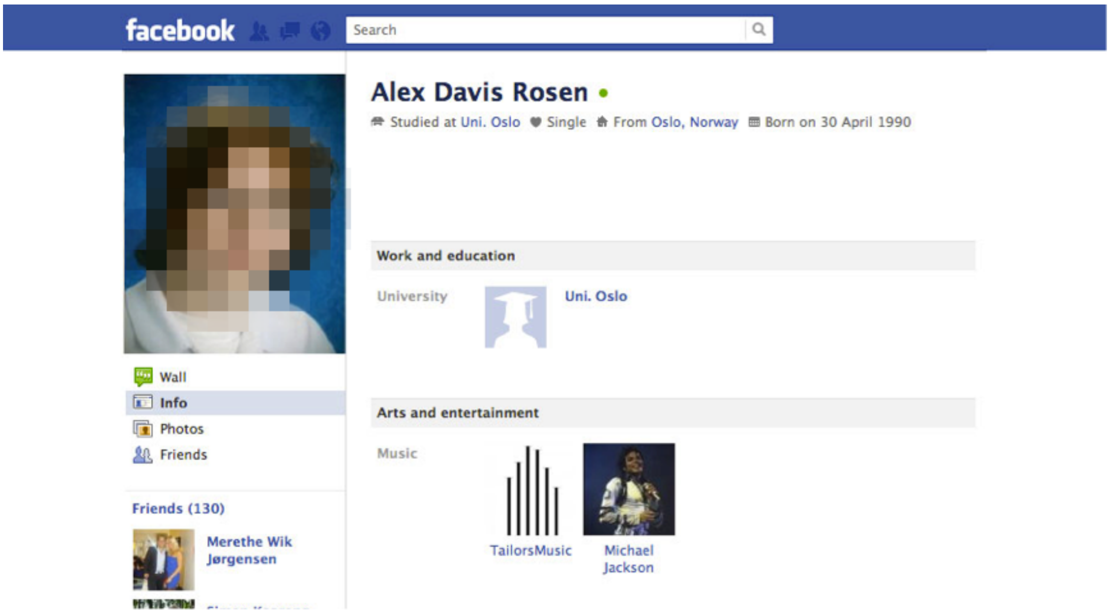
Participant 5 – Boy, age 13-15

Like participant 4, this participant was among the youngest, and his cultural probe illustrates a rather different perspective of exercise motivation than the older participants. Although he too committed relatively sparsely to the cultural probe, some observations can still be deduced. His major form of exercise was through playing soccer, which he stated he did voluntarily and for fun, in fact it appears he played it at every available opportunity. Additionally, he tended to suffix "soccer" with a pictogram of a smiling face and even wrote, "*[…] played more soccer. I almost sweat to death*". Hence it is obvious that his exercise motivation was caused intrinsically.

Additionally, and equivalently with participant 4, this participant's associations with exercise differ slightly from those who this thesis considers internal extrinsically motivated. While those who are internal extrinsically motivated tended to associate exercise with detached goals such as healthy, slim and strong body as well as feelings of accomplishment (for example participant 1 and 2), these younger participants seemed to regard exercise more as voluntary and fun. In the context of this thesis, it shows that if a person regards an exercise activity as enjoyable, he or she is more likely to be motivated to perform that activity, both more frequently and intensely. This suggests that intrinsic motivation is greatly effective in causing exercise, which is in accordance with motivational psychology introduced earlier in the theory chapter.

Appendix D: Personas

Persona 1



Bakgrunn:

- Deltar ikke på gymtimer vha legeattester
- Har aldri spilt noen sport på fritiden, og har heller aldri hatt noe ønske om det.
- Synes at fysisk aktivitet rett og slett ikke er morsomt

Psyke:

- Føler ikke at han har noe behov for å trene
- Har ikke tro på at trening vil få han i bedre form
- Har prøvd tidligere å begynne med trening, men har gitt opp siden han ikke så noen progresjon
- Mål: ønsker å komme i bedre form (kroppsbilde), men tror ikke trening fungerer for han
- Frustrasjon: Synes ikke at noen trenings-spill er gøy og har ikke tro på at de vil få han i bedre form

Forhold til teknologi:

- Interessert i alt som er relatert til teknologi
- Spiller mange spill aktivt, som WoW, Skyrim, Halo

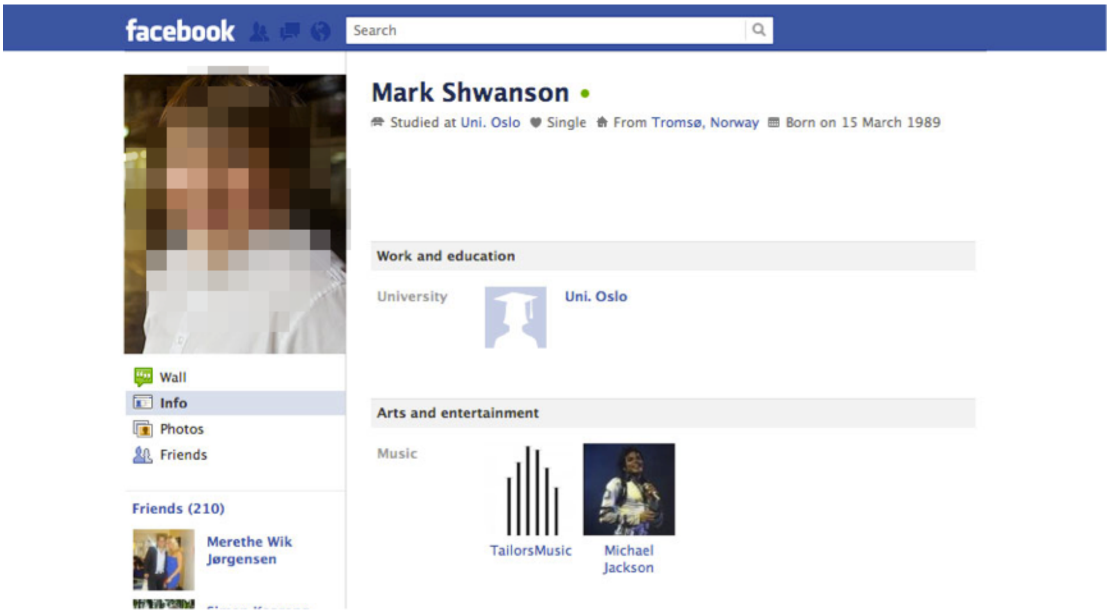
Mål (treningsapplikasjon):

- Hadde satt pris på muligheten til å trene hjemme i stedet for sammen med andre

- Ønsker å kunne se progresjon i treningen slik at han kan se at det fungerer.

Sitat:
"Exercising apparently does not work for my kind of body."

Persona 2



Bakgrunn:
- Foreldrene presser han til å spille fotball en gang i uken

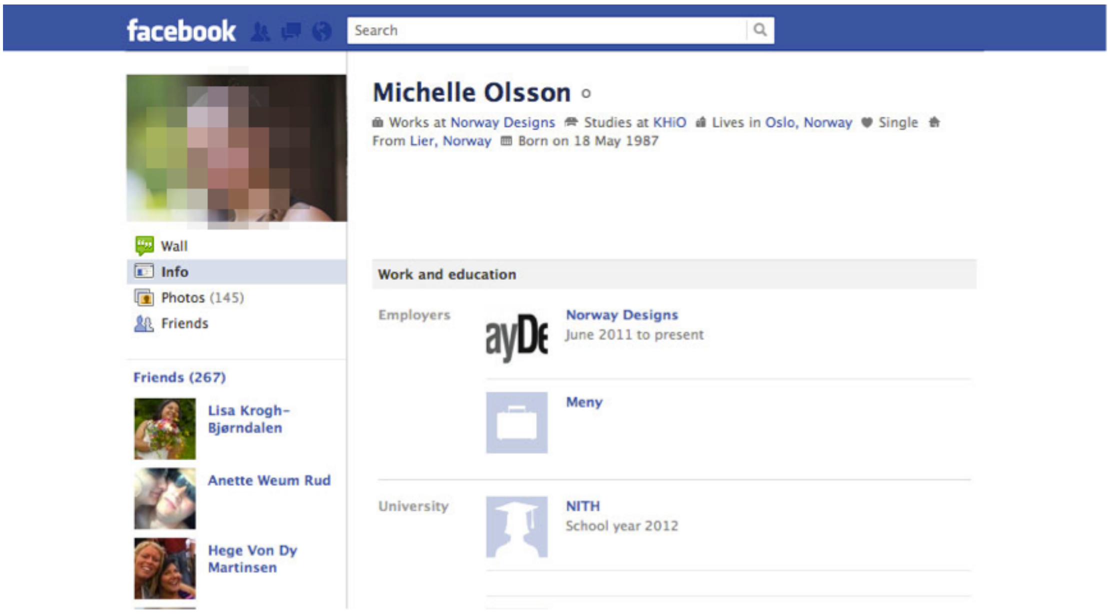
Psyke:
- Føler ikke at han er noe særlig god på verken fotball eller i gymtimene
- Synes det lite givende å trene
- Blir demotivert av at alle andre er i bedre form
- Mål: trener for å ikke skuffe foreldrene sine
- Frustrasjon: Synes ikke at noen trenings-spill er gøy, og vil heller spille andre spill.

Forhold til teknologi:
- Interessert i alt som er relatert til teknologi
- Spiller mange spill aktivt, som WoW, Skyrim, Halo

Mål (treningsapplikasjon):
- Hadde satt pris på muligheten til å trene hjemme i stedet for sammen med andre
- Ønsker et trenings-spill som er underholdende

Sitat:
"I wish my parents didn't pressure me to exercise. I wish I would enjoy it myself."

Persona 3



Bakgrunn:
- Trener på SATS 2-3 ganger i uken
- Går på diverse treningstimer
- Trenger i ca. 1 time om gangen

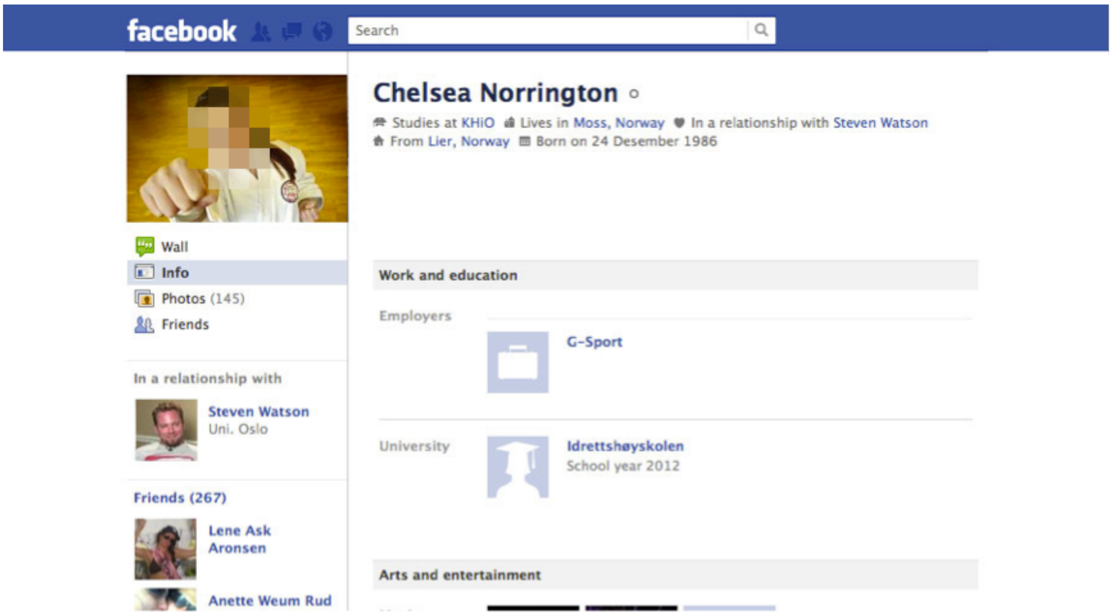
Psyke:
- Føler seg bra etter trening. Føler at trengingen var artig dersom hun har gjort det bra.
- Trener for å holde seg i god form og helse
- Drar på timer fordi instruktørene er motiverende
- Synes at treningen er verken artig eller kjedelig.
- Mål: vær sunn, ha sunn vekt
- Frustrasjon: Terningspill som Fitness Evolved er kjedelige og de andre spillene føles ikke ut som trening.

Forhold til teknologi:
- Lite opptatt av dingser og teknologi
- Spiller ikke dataspill

Mål (treningsapplikasjon):
- Mulighet til å trene ordentlig hjemme slik at hun kan trene oftere og treningen må være ordentlig trening.
- Må vite at hun kommer i bedre form av treningen hjemme.

Sitat:
"We do not stop exercising because we grow old – we grow old because we stop exercising"

Persona 4



Bakgrunn:
- Trener Karate aktivt
- Konkurrer på et nasjonalt nivå
- Trener ca. 3 timer om dagen hver dag sammen med Karate-klubben
- Har prøvd mange andre idretter, bla. Snowboard og Kung-Fu

Psyke:
- Er sosial med klubben, men sjelden med andre pga. turneringer og trening
- Pusher seg selv, målbevisst
- Synes at karate er morsomt og givende.
- Trener fordi hun har lyst å bli bedre, og delvis pga. det sosiale.
- Mål: Vinne NM i karate.

Forhold til teknologi:
- Lite opptatt av dingser og teknologi
- Spiller ikke dataspill

Mål (treningsapplikasjon):
- Mulighet til å trene ordentlig hjemme slik at hun kan trene oftere.
- Må vite at hun kommer i bedre form av treningen hjemme slik at hun kan bli bedre i Karate.

- Frustrasjon: Hun finner ingen trenings-spill som er på høyt nok nivå for henne og de hun har prøvd er rett og slett kjedelige.

Sitat:
”What fits your exercise schedule better, exercising one hour a day or being dead 24 hours a day?”

Appendix E: Interview script

Goal 1: Find out if the prototype contributes to giving more feedback about the exercise than without. Is it more distracting than helpful? Is the information relevant? Does the information contribute to more feedback?

- Hva tror du den progress bar'en der gir deg for informasjon?
- Hva tenker du om at du får de audio-kommentarene mens du spiller?

- Hva slags inntrykk får du av treningen din vha denne applikasjonen?
- Hva slags inntrykk får du av informasjonens troverdighet?
- Hva er det som får deg til å stole/ikke stole på informasjonen?
- Hva kunne ha bidratt til at informasjonen hadde blitt mer troverdig?
- Føler du at informasjonen er relevant eller er noe overflødig?
- Hva slags informasjon kunne du ha tenkt deg å få fra en tilleggs-applikasjon som dette?
- Bruker du annet utstyr for å måle din treningsaktivitet?
- Hvis ja, føler du at du trener bedre ved å bruke den?

Goal 2: Find out if the prototype helps increase the test subject's feeling of mastery (specifically to exercising).

- Føler du at treningen din var bedre med eller uten applikasjonen?
- Hvis den var bedre med/uten, hva var det som bidro til det?
- (Føler du at spillet ble mer eller mindre givende å spille med denne applikasjonen?)

- Føler du at spillopplevelsen din ble negativt eller positivt påvirket av applikasjonen?
- Hvilken påvirkning hadde denne applikasjonen på din spillopplevelse?
- Hvilken påvirkning hadde denne applikasjonen på din trening?

Appendix F: NSD receipt

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

NSD

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Jo Herstad
Institutt for informatikk
Universitetet i Oslo
Postboks 1080 Blindern
0316 OSLO

Vår dato: 10.10.2011 Vår ref: 27838 / 3 / MAB Deres dato: Deres ref:

KVITTERING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 30.08.2011. All nødvendig informasjon om prosjektet forelå i sin helhet 07.10.2011. Meldingen gjelder prosjektet:

27838	*Exercise and NUI*
Behandlingsansvarlig	*Universitetet i Oslo, ved institusjonens øverste leder*
Daglig ansvarlig	*Jo Herstad*
Student	*Moquan Chen*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven/-helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/forsk_stud/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://www.nsd.uib.no/personvern/prosjektoversikt.jsp.

Personvernombudet vil ved prosjektets avslutning, 31.12.2012, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Marte Bertelsen

Kontaktperson: Marte Bertelsen tlf: 55 58 33 48
Vedlegg: Prosjektvurdering
Kopi: Moquan Chen, Rathkes gate 12 C, 0558 OSLO

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TROMSØ: NSD. HSL, Universitetet i Tromsø, 9037 Tromsø. Tel: +47-77 64 43 36. martin-arne.andersen@uit.no

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 27838

Formålet med prosjektet er å utvikle et dataprogram som oppfordrer til fysiske engasjement blant tenåringer.

Utvalget består av ungdommer i alderen 15-20, tilsammen ca. 5 personer.

Utvalget rekrutteres fra eget nettverk.

Det gis skriftlig informasjon og innhentes skriftlig samtykke i prosjektet.

Informasjonsskrivet som skal nyttes i prosjektet, mottatt av ombudet 07.10.2011, finnes tilfredsstillende. Men setningene "All informasjon og data skal anonymiseres etter beste evne og vil kun bli brukt i sammenheng med prosjektet. Ingen personidentifiserbare informasjon vil bli samlet inn." bør slettes, jf. telefonsamtale med student 07.10.2011.

Ingen enkeltpersoner vil kunne gjenkjennes i publisering fra prosjektet.

Prosjektslutt er 31.12.2012. Ved prosjektslutt skal videoopptak slettes og datamaterialet anonymiseres.

Thank you for reading!

Moquan Chen & Stian Aune Kilaas